AD NUMBER
AD855243
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited. Document partially illegible.**
FROM: **Distribution: Further dissemination only as directed by Army Materiel Command, Attn: AMCRD-GV, Washington, DC 20315, APR 1969, or higher DoD authority.**
AUTHORITY
USAMC ltr, 5 Dec 1971

RDT&E PROJECT NO Unknown

USATECOM PROJECT NO 1-8-7340-60

AD855243

20

PRODUCT IMPROVEMENT TEST OF

T132E1 SNOW PADS FOR

M578 RECOVERY VEHICLE

UNDER ARCTIC WINTER CONDITIONS

FINAL REPORT

BY

LT JOSEPH P. DURSO, JR.

AND

SP5 ROBERT A. WAYNE
SCIENTIFIC AND ENGINEERING

APRIL 1969

U. S. ARMY ARCTIC TEST CENTER

APO SEATTLE 98733

STATEMENT #5 UNCLASSIFIED

This document may be further ~~distributed by any holder~~ only with specific prior approval of C.G. Army Materiel Comd. Attn: AMCRD-GV Wash, D.C. 20315

DDC Availability Notice

U. [redacted] copies [redacted]ly from [redacted]C.

Reproduction Limitations

Reproduction of this document in whole or in part is prohibited except with permission of HQ, USAMC. DDC is authorized to reproduce the document for United States Government purposes.

Disposition Instructions

Destroy this report when it is no longer needed. Do not return it to the originator.

Disclaimer

The findings in this report are not to be construed as an official Department of the Army position. unless so designated by other authorized documents issued and approved by the Department of the Army.

This document may be further distributed by any holder only with specific prior approval of U. S. Army Materiel Command.

RDT&E PROJECT NO. UNKNOWN

16 USATECOM [redacted]-1-8-7340-60

11

PRODUCT IMPROVEMENT TEST OF

T132E1 SNOW PADS FOR

M578 RECOVERY VEHICLE

UNDER ARCTIC WINTER CONDITIONS,

9 FINAL REP[redacted]T, 18 N.

[redacted]

10 [redacted] JOSEPH P. DURSO, JR.

[redacted]

[redacted] ROBERT A. WAYNE

[redacted]

11 APR[redacted]69

12 67p

APPROVED:

EDWIN M. RHOADS
Colonel, Armor
Commanding

U. S. ARMY ARCTIC TEST CENTER

APO SEATTLE 98733

ABSTRACT

A Product Improvement Test was conducted on the T132E1 Track Snow Pads for the M578 recovery vehicle by the U. S. Army Arctic Test Center at Fort Greely, Alaska from 18 November 1968 to 31 March 1969. The test was conducted to determine if the T132E1 track snow pads increased the mobility of the M578 recovery vehicle over arctic winter terrain.

Three test pad designs were evaluated: low durometer rubber, spring loaded low durometer, and steel grouser.

The test approach used was to first determine which snow pad design provided the greatest vehicle mobility and then to test that design for durability under the prevailing environmental conditions. Initial testing of all three types snow pads revealed the low durometer rubber snow pad provided the best performance in the areas of mobility, slope performance and tractive efforts over the steel grouser and spring loaded snow pads. Durability of the low durometer pad was adequate except for frequent loosening of the retaining nut.

It was concluded that the low durometer snow pad increases the mobility of the M578 recovery vehicle more than any other track pad configuration tested under arctic winter conditions. It was recommended that the low durometer rubber snow pads be adopted for U. S. Army use under arctic winter conditions after the retaining nut reliability failure has been resolved. Further testing at this Center was not recommended.

FOREWORD

The U. S. Army Arctic Test Center, Fort Greely, Alaska was responsible for preparing the test plan, executing the test, and preparing the test report.

The authority to conduct this test is contained in letter, AMSTE-BB, HQ, USAATC, 15 August 1968, subject: USATECOM Project No. 1-8-7340-60, Product Improvement Test of T132E1 Track Snow Pads for M578 Recovery Vehicle, DA Project Code NKB.

Tests were conducted from 18 November 1968 to 31 March 1969 by members of the Armor and Combat Vehicles Test Divsion, U. S. Army Arctic Test Center. The assistance of PFC G. T. Cantu and PFC J. R. Castleman, Scientific and Engineering, Instrumentation and Test Methodology Division, U. S. Army Arctic Test Center, in collecting, reducing and analyzing engineering test data is acknowledged.

TABLE OF CONTENTS

DEPARTMENT OF THE ARMY
UNITED STATES ARMY ARCTIC TEST CENTER
APO SEATTLE 98733

FINAL REPORT
FOR
PRODUCT IMPROVEMENT TEST OF T132E1 SNOW PADS FOR
M578 RECOVERY VEHICLE
UNDER ARCTIC WINTER CONDITIONS

RDT&E PROJECT NO. UNKNOWN   USATECOM PROJECT NO. 1-8-7340-60

SECTION 1. INTRODUCTION

1.1 BACKGROUND

The M578 recovery vehicle does not perform satisfactorily under the particular arctic winter conditions of hardpacked/packing snow. Track performance is one of the factors which contributes to this problem. With the standard T132E1 track pads installed, the ground pressure is low and the grousers do not penetrate the hard-packed snow and cannot provide the aggressiveness required for the desired mobility. With track pads removed, the snow fills the rectangular pad cavities and packs to the top of the grousers and the same situation as noted above results. In order to resolve this problem, three snow pads have been designed to increase the ground pressure.

The three types of snow pads to be tested have been designed to improve the mobility of the M578 recovery vehicle under arctic winter conditions. Performance testing of the three types of snow pads was conducted at Fort Wainwright, Alaska, from 16-20 March 1968 by Arctic Test Center personnel with the aid of USARAL. A partial report was submitted in June 1968 (reference g, appendix IV) covering this initial test. Results of this test, although inconclusive, indicated that the improved snow pads exhibited sufficient mobility to warrant further testing.

Because of this historical lack of mobility of the standard track with the standard pad, this configuration was eliminated from further competition with the improved pads.

1.2 DESCRIPTION OF MATERIEL

The T132E1 track is a single pin rubber bushed track 18 inches wide with a 6-inch pitch. Two basic type snow pads have been designed to be interchangeable with the T132E1 production pad. Descriptions of the functional operation of each approach are as follows:

a. Steel grouser imbedded in low durometer rubber [illegible]

When installed in the T132E1 track shoe, the [illegible] filled with low durometer rubber and the steel [illegible] extended beyond the track shoe grousers. This extended [illegible] vided the high ground pressure required for penetration [illegible] snow

b. Resilient snow pad.

Two types of resilient snow pads [illegible] The low durometer rubber snow pad, is designed [illegible] the snow pad, when installed in the [illegible] a flat smooth rubber surface which is slightly [illegible] The protruding edges of the track cavity sides then [illegible] the purpose of this pad is to maintain the cavity [illegible] snow by the resilient action of the low durometer [illegible] ground pressure can be maintained on the cavity edges

The second type, the spring [illegible] has the same appearance, when installed [illegible] snow pad. This single difference [illegible] of the pad is obtained through the use of [illegible] stalled [illegible] the pad in the track cavity [illegible] the rubber

[illegible] OBJECTIVE

Determine if the T132E1 track snow pads increase the [illegible] of the recovery vehicle over arctic winter terrain

[illegible] SUMMARY OF RESULTS

[illegible] and hours accumulated [illegible] as follows:

	Miles	[illegible]
[illegible] pads	[illegible]	[illegible]
Steel grouser pads	536.[illegible]	[illegible]
Spring loaded pads	202.[illegible]	[illegible]

The spring loaded low durometer rubber pad was eliminated from competition after 202.9 miles. Because of the low torque on the retaining nut, rock and gravel penetrated the gap between the rubber pad and the pad cavity causing the pad to curl up at the edge, causing chunking of the pad.

Results of competition to determine the pad which provided the best overall vehicle performance are as follows:

a. Mobility.

(1) The low durometer snow pads are superior to other track pad configurations on secondary roads covered with hard-packed snow and on cross-country trails with longitudinal slopes and other obstacles, including deep snow (paragraph 2.3, section 2).

(2) The steel grouser pads are superior to other track pad configurations on flat cross-country trails with numerous curves in deep snow (paragraph 2.3, section 2).

(3) The low durometer pads demonstrate complete self-cleaning capability while the steel grouser pads do not, especially at ambient temperatures below -25°f when they tend to become packed with frozen snow (paragraph 2.3, section 2).

(4) Vehicles equipped with low durometer snow pads are able to attain higher safe speeds on secondary roads covered with hard-packed snow than vehicles with steel grouser pads (paragraph 2.3, section 2).

(5) Both the low durometer and steel grouser snow pads are superior to T132E1 track without pads (paragraph 2.3, section 2).

b. Slope Performance.

(1) The vehicle equipped with low durometer snow pads outperformed the vehicle equipped with steel grouser pads on longitudinal slopes (paragraph 2.4, section 2).

(2) Both the low durometer and steel grouser equipped vehicles were capable of operating on 40 percent side slopes (paragraph 2.4, section 2).

(3) The braking ability of the steel grouser equipped vehicle on longitudinal slopes was superior to that of the low durometer equipped vehicle (paragraph 2.4, section 2).

(4) The packing of snow within the steel grouser snow pads at low ambient temperatures greatly limits the ability of these pads to ascend longitudinal slopes covered with hard-packed snow and ice. The low durometer pads, with effective self-cleaning action, are superior in these conditions (paragraph 2.4, section 2).

c. Tractive Effort.

The vehicle equipped with low durometer snow pads provided consistently superior performance in comparison with all other track pad configurations tested on both hard-packed and deep undisturbed snow (paragraph 2.5, section 2).

Competitive testing of all three snow pads proved that the low durometer rubber snow pad was the one providing greatest overall vehicle performance, and this pad only was subjected to durability and reliability testing. The results of durability testing are as follows:

a. The low durometer snow pads have not been designed to minimize maintenance. The retaining nut will not retain the required torque of 160 foot-pounds (paragraph 2.6, section 2).

b. The low durometer snow pad is durable for at least 2,000 miles under arctic winter conditions (paragraph 2.6, section 2).

c. The standard issue OEM tools supplied with the test vehicle are not adequate to maintain the test snow pads as no manual torque wrench is provided, and an additional 15/16-inch socket is required (paragraph 2.6, section 2).

1.5 CONCLUSIONS

It was concluded that:

The low durometer snow pads increase the mobility of the M578 light recovery vehicle more than any other track pad configuration tested under arctic winter conditions.

The low durometer snow pad is durable for at least 2,000 miles under arctic winter conditions.

The retaining nut on the low durometer snow pad is not reliable under arctic winter conditions.

The steel grouser snow pad is not suitable for use under arctic winter conditions because the grouser consistently becomes packed with frozen snow and ice, eliminating effective aggressive action.

The spring loaded snow pad is not suitable for use under arctic winter conditions because snow and gravel penetrate the gap between the pad and the pad cavity.

The vehicle OEM is not adequate to maintain the test snow pads under arctic winter conditions.

1.6 RECOMMENDATIONS

It is recommended that:

The low durometer snow pads be adopted for use under arctic winter conditions after the retaining nut reliability failure has been resolved.

The steel grouser and spring loaded snow pads not be considered suitable for use under arctic winter conditions.

The vehicle OEM be increased to include a manual torque wrench and an additional 15/16-inch socket for use with the snow pads under arctic winter conditions.

Further testing at this Center is not recommended.

SECTION 2. DETAILS OF TEST

2.1 INTRODUCTION

Testing consisted of operating the M578 recovery vehicle, with the T132E1 track and test pads mounted, over typical cross-country arctic winter terrain to include both side and longitudinal slopes. Further evaluation of the test pads was made to determine tractive effort, maneuverability, maintainability and reliability, vibration and crew comfort.

The test approach used was to first determine which pad design provided the greatest vehicle mobility and then to test that design for durability under the prevailing environmental conditions. Any possible other effects on vehicle performance were also evaluated and reported.

Snow conditions proper for testing were extremely limited, and the test plan was modified to allow for best use of available testing conditions.

A second M578 recovery vehicle was used as a comparison vehicle. The test vehicle's performance with each type of snow pad installed was compared with the comparison vehicle's performance with other test pads installed. These different track pad configurations were compared during all operational sub-tests.

When not being used for operational sub-tests, the test and comparison vehicles, with tracks installed, remained in an unsheltered area except for those periods when maintenance indoors was required.

All operational sub-tests were conducted under as wide a range of temperatures and snow conditions as were available. Particular emphasis was placed on obtaining performance data of the test pads' performance on hard-packed snow.

During all arctic winter tests, as appropriate, crewmen were dressed in the arctic winter uniform (appendix III).

2.2 PREOPERATIONAL INSPECTION

2.2.1 Objective

Determine if the test track and comparison track are in proper condition for test operations.

2.2.2 Method

The test track and snow pads were inspected, measured and photographed.

One set of test pads was installed on one M578 recovery vehicle, and another set of test pads was installed on the other M578. The track of both vehicles was inspected to insure proper condition and track tension at the start of the test.

2.2.3 Results

Low Durometer Snow Pads: The pads were installed at the beginning of the test season and remained on the vehicle throughout the test.

The pads were new No defects were detected during the inspection and measurement of the pads.

No major problems were encountered during installation. The rubber pads are slightly larger than the cavity in the track, and, as the bolts were tightened, the rubber molded itself into the shape of the track cavity. With the bolts fully torqued to 160-foot pounds, the upper edge of the pads was well below the edge of the track cavity.

Spring Loaded Snow Pads: The spring loaded pads were installed midway through the test season The pads had been installed for a short time during the FY68 test season, and were slightly worn, but still serviceable and in proper condition for testing.

Because of the two-piece construction of the pad, the time (manhours) to install the pads was much longer than the time to install the other two test pads (paragraph 2.6, section 2).

No defects were detected during inspection of the pads.

Steel Grouser Snow Pads. These pads were installed at the beginning of the season The pads had been tested for draw-bar pull and slope performance during the FY68 test season, and stored outdoors during the summer. The steel grousers were worn slightly and rusted. The bolts were also rusted, some of the nuts frozen in place and some of the threads stripped.

These defects made installation difficult, particularly when the crew placed the pads in the track cavity and tightened the nuts. The steel grouser pads were removed midway through the season, and replaced when testing of the spring loaded pads was complete. Before replacement was possible, the bolts of 35 steel grouser pads had to be rethreaded.

Photographs of the test pads are included in figures 1 through 3, appendix I. Measurements of test pads are included in tables 1 and 2, appendix I.

2.2.4 Analysis

The low durometer and spring loaded snow pads were ready for testing.

After installation difficulties had been overcome, the steel grouser snow pads were ready for testing.

2.3 MOBILITY

2.3.1 Objectives

Evaluate the snow-covered cross-country mobility characteristics of each type test snow pads.

Determine which track pad configuration enables the M578 to achieve the highest safe speed on a hard-packed, snow-covered, level road surface.

2.3.2 Method

One set of test snow pads mounted on one M578 and a comparison track pad configuration mounted on the second M578 were operated at maximum safe speeds over an established snow-covered cross-country course. The ability of both vehicles to negotiate the course was evaluated.

The test and comparison vehicles were operated over snow-covered terrain features not encountered on the established course in order to determine the maximum snow depth that the vehicles could negotiate.

During the conduct of all cross-country operations, observations were made with respect to the performance of both the test and comparison vehicle, noting specifically maneuverability, ease of steering, vibration and crew comfort.

The test and comparison vehicles were accelerated to the maximum safe speed obtainable on a hard-packed, snow-covered, level road surface. The governing factor was the driver's ability to safely control the vehicle.

Only the low durometer and steel grouser test snow pads underwent cross-country mobility testing The spring loaded test pad had failed the durability requirement during draw bar pull exercises and was eliminated from further testing. These two pads were evaluated against each other and against the standard T132E1 track without pads.

2.3.3 Results

The low durometer pads demonstrated complete self-cleaning action in all temperature and snow conditions. As the pads cleared the drive sprocket just prior to contact with the ground, any snow that had accumulated in the pad cavity was thrown out, and clean track with the edges of the track cavity exposed was used to drive the vehicle. With this self-cleaning action, and with the edges of the track cavity clean, the track was extremely aggressive.

The steel grouser pad became packed with snow up to the level of the steel grousers, eliminating any aggressive action clean grousers could supply. This was particularly apparent at ambient temperatures below -25°F, when snow would freeze into the track, beginning in the "V" formed by the grousers and eventually extending over the entire pad. At higher ambient temperatures, the problem was less severe, but the pad always had a tendency to accumulate snow, and had poor self-cleaning capability.

Similarly, the track without pads would become clogged with frozen snow at low ambient temperatures, eliminating the aggressive action at the sides of the track cavity. This configuration had no self-cleaning capability whatsoever.

On hard-packed snow-covered surfaces, the M578 equipped with low durometer pads was able to execute a pivot turn with the inside track locked throughout the turn. The vehicle equipped with steel grouser pads free from snow was unable to make the same turn without momentarily unlocking the inside track. It is possible that the chevron shaped grouser caused a resistance to lateral movement, beneficial when operating on side slopes, but deleterious when maneuvering on a level surface covered with hard-packed snow. When the grousers were packed with snow, the resistance to lateral movement was eliminated, but the outside track had trouble gaining enough traction to push the vehicle around.

Operators were able to control the vehicle equipped with low durometer pads at higher speed than they were able to control the vehicle equipped with steel grouser track pads. This was true particularly at times when the grouser pads were packed with frozen snow. On hard-packed snow-covered secondary roads, the vehicle with steel grouser pads would slip as operators accelerated to higher speeds.

After operating vehicles equipped with both low durometer and steel grouser pads over a deep snow (up to 18 inches) covered cross-country trail, test personnel reported slightly greater ease in negotiating curves with the steel grouser pads. The vehicles were operated at the same speed, with drivers operating first one vehicle and then the other. The ambient temperature during these tests was above -25°F, and the grousers were not completely packed with snow. This advantage was not present on longitudinal slopes, and on several instances, the vehicle equipped with low durometer pads was able to climb slopes which the vehicle equipped with steel grouser pads was forced to go around.

The maximum snow depth the vehicles were able to negotiate was not determined because of unsuitable snow conditions during the test season.

Early in the test season, the vehicle with low durometer pads recovered the Marine Corps LVTRX-2 recovery vehicle which had broken down while traveling through deep snow on a cross-country trail. The vehicle weighed approximately 25 tons. The M578 recovered it over 2 1/2 miles of cross-country trail through snow up to approximately 18 inches in depth. The route of recovery included several hills of approximately 20 percent slope, small trees, frozen muskeg, and hard-packed secondary roads. Starting on flat gound in deep snow, the operator accelerated to maximum speed and maintained that speed until the vehicle reached the secondary road. At one point on the secondary road, the vehicle was forced to halt to permit another vehicle to pass at an intersection. From a stop on a hard-packed snow-covered secondary road, the vehicle made a 180-degree climbing turn while pulling the LVTRX-2. The turn was extremely tight, and the M578 was forced to pivot several times to bring the Marine Corps vehicle around. When the recovery was completed, the M578 was used to maneuver the LVTRX-2 into its parking space against a fence.

On another occasion, the M578 equipped with steel grouser snow pads was used to recover an M551 Sheridan Armored Assault Vehicle over 16 miles of hard-packed, snow-covered secondary roads. The M551 weighs approximately 16 tons. The route of recovery included several longitudinal slopes of approximately 30 percent. The operator was able to maintain a slow speed, which decreased on the slopes. At slow speeds, the driver reported little difficulty in control. The M578 was used to maneuver the M551 in close quarters at the end of the mission. On other occasions, the vehicle with steel grouser pads recovered the Marine Corps LVTRX-2 for distances of up to 3/4 of a mile over flat secondary roads covered with hard-packed snow.

2.3.4 Analysis

The low durometer snow pads are superior to other track pad configurations on secondary roads covered with hard-packed snow.

The low durometer pads are superior to other track pad configurations on cross-country trails with longitudinal slopes and other obstacles, including deep snow.

The steel grouser pads are superior to other track pad configurations on flat cross-country trails with numerous curves in snow greater than 12 inches deep. This is true at higher ambient temperatures, when the grousers are not packed with snow.

The low durometer pads demonstrate complete self-cleaning action. The steel grouser pads do not demonstrate self-cleaning capability, especially at ambient temperatures below -25°F, tending to become packed with frozen snow, eliminating their aggressive action.

Both test pad configurations are superior to T132E1 track without pads.

Vehicles equipped with low durometer pads are able to attain higher safe speeds on secondary roads covered with hard-packed snow than vehicles with steel grouser pads.

2.4 SLOPE PERFORMANCE

2.4.1 Objectives

Determine if the vehicle with test pads or comparison vehicle with and without standard pads is capable of ascending and descending a deep, snow-covered and a hard-packed, snow-covered, longitudinal slope of up to 60 percent.

Determine if the vehicle with test pads or comparison vehicle with and without standard pads is capable of operating on a deep snow-covered and a hard-packed, snow-covered side slope of up to 30 percent.

Determine if the vehicle with test pads or comparison vehicle with and without standard pads is capable, by driver application of service brakes, of being controlled while heading either up or down a deep snow-covered, and a hard-packed, snow-covered, longitudinal slope of up to 60 percent.

2.4.2 Method

Before negotiating the various snow-covered slopes, the engine, transmission, and brakes were checked and adjusted on both vehicles to insure optimum performance.

Poor snow conditions in the test area made a complete comparison of all track pad configurations impossible. Consequently, the test officer modified the method outlined in the Plan of Test to make best use of available snow conditions on a variety of slopes in the Fort Greely area. Based on results of mobility, durability, and draw-bar pull tests, the low durometer rubber and steel grouser snow pads, and the two superior track pads, were selected for slope testing. These were tested on the graded slope test range, and on unimproved slopes along cross-country trails.

One track pad was mounted on one M578, and the other was installed on the comparison vehicle. The capability of the vehicles to ascend and descend 30, 40, 50 and 60 percent slopes was determined.

The brake holding ability of the vehicles on 30, 40, 50 and 60 percent longitudinal slopes was determined for service brakes, with the vehicles headed both up and down the slopes for 5-minute periods.

Operation on the 20 to 40 percent snow-covered side slope was conducted with the vehicle moving both forward and backward.

The same driver was used to test both vehicles, to eliminate driving technique as an influencing factor.

Two longitudinal slope tests and one side slope test were performed during the season. In addition, test personnel recorded observations on the relative performance of the two snow pads on slopes encountered throughout the test season.

2.4.3 Results

For the first test, the maximum available snow-covered slope was 37 percent near the summit of the slope. Snow conditions varied from 12 to 14 inches of loose, powdery snow on the approaches to the maximum slope, and 4 inches of loose snow over 2 inches of hard-packed snow and ice on the 37 percent portion of the slope. This slope was found on a cross-country trail, and was typical of slopes in the Fort Greely area. Ambient air temperature was -12°F.

Neither vehicle was able to negotiate the slope from a standing start in deep snow. The steel grouser equipped vehicle successfully negotiated the slope on the third attempt from a running start on level ground. Extensive track slippage was observed. The vehicle with low durometer pads climbed the slope on the first attempt from a running start on level ground. Very little track slippage was observed. The steel grouser pads were packed with frozen snow above the level of the grousers, which caused the tracks to slip on the ice on the 37 percent slope. The low durometer pads were free of snow in the track cavities, and the edges of the track cavities were able to grip the surface of the slope. Detailed results of this test are contained in table 3, appendix I.

The second test was conducted on the graded slope test range, comprising slopes of 30 to 60 percent. Snow conditions varied from 12 inches of loose snow at the base of the slopes to 4 inches of loose snow near the crest of the slope on top of a frozen gravel surface. Ambient temperature was -40°F.

The steel grouser equipped vehicle was able to negotiate a maximum longitudinal slope of 40 percent, with a running start. It had failed to negotiate the slope in three attempts from a standing start. The steel grousers were packed with snow, which was thrown off when the slipping track penetrated down to the gravel surface. The vehicle with low durometer pads climbed the 50 percent slope from a running start, after three failures from a standing start. The low durometer equipped vehicle was unable to negotiate the 60 percent slope from a running start The track pads were free of packed snow.

Both vehicles were able to climb half way up the 50 percent longitudinal slope before 100 percent track slippage occurred When the driver decelerated to reduce track slippage, the vehicle equipped with low durometer pads was able to regain traction and continue to the top of the slope The vehicle with steel grouser pads mounted did not have this capability.

The operator had no difficulty stopping the vehicle with steel grousers on the descent of the 40 percent slope, and brake holding ability was satisfactory. When the brakes were applied to the vehicle with low durometer pads, the vehicle slipped approximately 4 feet before halting. Brake holding ability was satisfactory The same difficulty was observed with low durometer pads when the brakes were applied on the 50 percent slope

Both the steel grouser and low durometer equipped vehicles were operated on side slopes up to 40 percent The slope was covered with 6 to 12 inches of powder snow The test personnel observed no difficulties with either vehicle in negotiating the side slopes both forwards and backwards.

2.4.4 Analysis

The vehicle equipped with low durometer snow pads outperformed the vehicle equipped with steel grouser snow pads on longitudinal, snow-covered slopes.

Both the low durometer and steel grouser equipped vehicles were capable of operating on 40 percent side slopes covered with 6 to 12 inches of powder snow.

The braking ability of the steel grouser equipped vehicle on 40 percent snow-covered longitudinal slopes was superior to that of the low durometer equipped vehicle

Because of limited suitable snow conditions, no comparison was made between the spring loaded snow pads, or track without pads

The packing of snow in the steel grouser snow pads at low ambient temperatures greatly limits the ability of vehicles equipped with this track pad to ascend longitudinal slopes covered with hard-packed snow and ice. The low durometer pads, with effective self-cleaning action, are superior in these conditions

No track configuration tested was capable of climbing the 60 percent snow-covered slope.

2.5 TRACTIVE EFFORT

2.5.1 Objective

Compare the tractive effort of the vehicle with test pads and with and without standard pads on level, snow-covered surfaces under arctic winter conditions.

2.5.2 Method

Testing was conducted using MPT 2-2-604, Drawbar Pull, as a guide where applicable.

Immediately prior to tests, the vehicles were checked for proper mechanical performance, track tension was certified correct, and the engine and drive train were stabilized at operating temperatures.

A mobile drawbar pull test was conducted using standard tracks without pads and standard tracks with each set of test pads. The towing vehicle was operated in low range at full rack during all trials.

With the vehicles traveling at maximum safe speed, the towed vehicle gradually applied its brakes until the test vehicle came to a halt or its engine stalled.

Drawbar pull was continuously monitored using a load cell between the towing and the towed vehicles. Track slippage was calculated using data from a fifth wheel that measured the actual distance traveled by the towing vehicle and a sprocket counter that measured the apparent distance traveled by the tracks of the towing vehicle.

The vehicles were loaded with their normal payload.

Testing was conducted on level surfaces covered with hard-packed snow and on flat surfaces covered with deep, undisturbed snow. The snow surface temperatures ranged from -31°F to 30°F. The ambient temperatures ranged from -22°F to 38°F.

Since the two test vehicles were similar and each had a different set of pads, two sets of pads could be readily tested by alternating each vehicle as the towing vehicle.

A photograph of the instrumentation used and the hard vehicle-packed snow test area is shown by figure 15, appendix I.

It was not possible to adequately measure and describe the cross section of the deep snow courses due to the heterogeneity and rapid changes in consistency of the snow layers.

To facilitate the determination of the most suitable pad from among those tested, two test runs of drawbar pull versus percent slip taken the same day and under maximum similarity in conditions were plotted on each graph (figures 4 through 14, appendix I) Two different sets of pads could thus be compared.

2.5.3 Results

Comparison of spring loaded rubber pads versus low durometer rubber pads (figures 4-6, appendix I).

a. In 8 to 12 inches of undisturbed snow, the above pads showed similar characteristics at low slippage and drawbar pull. As the load was increased, however, the low durometer rubber pads demonstrated better traction than the spring loaded rubber pads For example, at 60 percent slip the low durometer rubber pads provided 23 percent more drawbar pull, (27,000 pounds versus 22,200 pounds respectively).

b. A comparison of low durometer pads versus spring loaded pads on hard-packed snow was not made due to packing of snow behind the spring loaded pad, resulting in distortion and, in some cases, failure (paragraph 2.1, appendix II).

c. Test personnel also reported that the spring loaded pads became similarly packed while conducting the trials in undisturbed snow.

Comparison of steel grouser pads versus low durometer rubber pads (figures 7-10, appendix I).

a. This comparison showed differences in performance, in favor of the low durometer rubber pads, both at low and high values of slippage and drawbar pull, on undisturbed snow as well as hard-packed snow At 50 percent slippage on undisturbed snow 11 inches deep the drawbar pull was 24,400 pounds for the low durometer rubber pads and 19,300 pounds for the steel chevron grouser pads in 12 inches of snow (figure 7, appendix I). At 50 percent slippage on hard-packed snow the drawbar pull was 29,000 pounds for the low durometer rubber pads, compared with 20,000 pounds for the steel chevron grouser pads under the same conditions (figure 9, appendix I).

b. Photographs of the low durometer rubber pads and steel chevron grousers are shown in figures 16 through 19, appendix I.

Comparison of tracks without pads and tracks with low durometer rubber pads (figures 11-14, appendix I).

a. At 80 percent slippage, in 12 inches of undisturbed snow, the drawbar pull measured for the tracks with low durometer rubber pads was 29,200 pounds compared with 26,600 pounds for the tracks without pads in 16 inches of undisturbed snow (figure 12, appendix I).

b. On hard-packed snow at 70 percent slippage the drawbar pull provided by the tracks with low durometer rubber pads was 23,200 pounds; 21,500 pounds were provided by the tracks without pads (figure 13, appendix I). Test personnel reported that the track without pads packed with snow, forming in effect, pads of ice.

2.5.4 Analysis

The T132 track fitted with the low durometer rubber pads provided consistently superior performance by comparison with all other track configurations tested, on both hard vehicle-packed and deep undisturbed snow.

Superior self-cleaning ability of the low durometer pads by comparison with the other designs was indicated as the reason for better performance on snow.

2.6 MAINTENANCE EVALUATION

2.6.1 Maintainability

2.6.1.1 Objective. Determine if the test items meet or exceed the maintainability standards of the T132E1 standard track pads in the arctic winter environment.

2.6.1.2 Method. Maintenance operations on the test items as outlined in TM 9-2320-238-10, were performed on the test snow pads. The time required for each maintenance operation was recorded and evaluated.

The standard T132E1 track pads were not used during the test cycle, because of limited testing conditions and the historical lack of mobility of these pads. The maintainability of the test pads was evaluated against experience with like-type items, and against the requirements of maintenance under arctic winter conditions

Maintenance operations were continuously monitored with regard to such factors as ease of handling, safety aspects and other human factors engineering implications These factors were evaluated to determine if the equipment has been designed to minimize maintenance.

2.6.1.3 Results. Total miles and hours accumulated on each of the snow pads during the test season are as follows:

		Miles	Hours
a.	Low durometer pads	2,173.9	172.6
b.	Steel grouser pads	536.4	41.4
c.	Spring loaded pads	202.9	19.8

Installation of the pads was accomplished at various times during the winter, as dictated by the progress of the test. Under normal circumstances, the pads would be installed before the beginning of winter and would remain on the vehicle until spring. The proper method of installation includes use of the vehicle-mounted hydraulic impact wrench. With one exception, the pads were installed when the ambient temperature was too cold for troops to work outdoors for extended periods of time. The test pads were installed indoors, using an electric impact wrench. A discussion of tools required for installation and maintenance appears in paragraph 2.6.3.

The low durometer pads were installed early in the test season, and remained on the vehicle until the end. The pads were new, and no problems were encountered during installation.

Total time to install a complete set of low durometer pads, including the removal of a complete set of standard pads and torquing all test pads to 160 foot-pounds, was 8 hours, 40 minutes. The average time to install one pad was 55.4 seconds, using the electric impact wrench and a torque wrench.

The steel grouser pads were installed early in the test season on the second M578. Time to install the entire set was 8 hours, 50 minutes, using the electric impact wrench. This includes the time to torque all pads to 160 foot-pounds. The pads were not new, and were rusted from storage outdoors during the summer. The crew had trouble tightening the nuts on many of the pads. This extended the total time of installation. On many pads, the threads were stripped, and the pads unserviceable.

The steel grouser pads were removed midway through the test season and reinstalled when testing of the spring loaded pads was terminated Total time to reinstall the complete set was 8 hours, 30 minutes, using the vehicle-mounted hydraulic impact wrench. After the pads were removed, 35 had to be rethreaded before they could be put back on the vehicle. The average time to install one pad varied from 20 seconds to 1 minute, 30 seconds, depending on the condition of the pad.

The spring loaded pads were installed midway through the test season. The pads were slightly worn from limited use during the FY67-68 test season, but were perfectly serviceable. The used condition did not hamper installation. However, the total time to install the set was extended by the two-piece construction of the pads. Total time of installation, including the removal of one set of steel grouser pads, was 13 hours, using the electric impact wrench. In many cases, the torque had to be adjusted down to the prescribed 20 foot-pounds. Some of the steel grouser pads were stuck in the track cavity and the crew was forced to hammer them out, damaging some of the bolts. The average time to remove one steel grouser pad and install one spring loaded pad was 3 minutes.

At the end of the season, the low durometer pads were removed from the test vehicle. Total time to remove all pads was 5 hours, 30 minutes. The average time to remove one pad was 2 minutes. During installation, the soft rubber of the pads became molded into the track cavity. The majority of the pads had to be hammered out of the track. Nine pads could not be removed, and still remain on the test vehicle.

The steel grouser pads were removed at the end of the test season Total time to remove the pad set was 3 hours, 55 minutes. Average time to remove one pad was 1 minute, 30 seconds. The pads had been on the vehicle only 142 miles, and removal was considerably easier the second time.

Only one maintenance problem was encountered during the test The low durometer test pads would not retain the torque of 160 foot-pounds, and had to be retorqued periodically This was discovered after the pads had been used for 1,812 2 miles (paragraph 2.6.2). A daily maintenance check showed that nine pads were missing. The torque on all pads was checked It ranged from 0 to 150 foot-pounds. Every pad on both tracks was loose. After 2,173 9 miles, another pad fell off A spot check of torque on both tracks revealed that four out of 11 checked on the left track were loose, and 16 out of 26 on the right track were below the prescribed torque of 160 foot-pounds. The entire set was retorqued.

A total of 2 16 operator-crew manhours was spent in maintenance during the test season The operations performed on each test pad are as follows:

a. Low durometer pads: replaced 10 missing pads and retorqued 188 pads; total time - 1 91 manhours

b Steel grouser pads: replaced one missing pad; total time - .08 manhours

c Spring loaded pads: replaced two missing pads; total time - .17 manhours

2.6.1 4 Analysis The low durometer snow pads have not been designed to minimize maintenance. The resilient characteristic of the pad used in self-cleaning action causes continued movement of the pad which may have led to the failure of the retaining nut to retain torque of 160 foot-pounds. With this type of snow pad, the standard bolt used on all track pads is not sufficient A completely self-locking bolt is required. In the absence of this, the torque must be checked at least every 500 miles.

The steel grouser test pads have been designed to minimize maintenance.

The spring loaded test pads failed the durability requirement early in the test cycle A determination of the maintainability characteristics of this pad was not made

Because neither the test nor comparison vehicle were tested with standard T132E1 track pads a determination of whether the test pads met or exceeded the maintenance standards of the standard track pads could not be made.

2.6.2 Durability

2.6.2.1 Objective. Assess the durability of the test items under arctic winter conditions and derive information regarding expected service life and required logistic support.

2.6.2.2 Method. The results of the Cross-Country Mobility, Slope Performance, and Drawbar Pull sub-tests were evaluated and showed that the low durometer rubber test snow pads were the most effective. A complete set (151 pads) of these snow pads was subjected to 2,000 miles of durability testing in two test cycles consisting of the following types of operation:

Terrain Condition	Test Miles
Hard-packed, snow-covered, secondary road	750
Hard-packed, snow-covered, secondary road with towed load	50
Snow-covered, cross-country	150
Snow-covered, cross-country, with towed load	50
Total test miles in one test cycle	1,000

The first test cycle included those miles accrued during the previously conducted snow mobility tests.

Prior to commencing durability testing, each snow pad was identified in a permanent manner so that records could be maintained with respect to total mileage accrued on each individual pad prior to removal due to failure or some other reason.

Upon conclusion of the durability test, the individual snow pad mileages were analyzed to determine with 90 percent confidence the expected life which 90 percent of the snow pads would exceed under similar conditions. Durability comments on the steel grouser pads can be found in table 2, appendix I, and on the spring loaded pads in paragraph 1.1, appendix II.

2.6.2.3 Results. Miles and type of operation accumulated on the low durometer rubber snow pad are as follows:

a. Secondary roads: 1,670.5 miles.

b. Secondary roads towing an M113: 105.8 miles.

c. Cross-country trails: 295.8 miles.

d. Cross-country trails towing an M113: 101.8 miles.

e. Total: 2,173.9 miles.

The following deficiencies were reported during the test season:

a. Seven low durometer rubber snow pads fell off the right track and two pads off the left track. Further investigation revealed all of the pads on both the left and right track were well below the prescribed torque of 160 foot-pounds ranging anywhere from 0 to 150 foot-pounds. A table showing each snow pad and its respective torque is contained in table 4, appendix I. Incident occurred after 1,812.2 miles of operation (paragraph 1.2, appendix II). (Deficiency)

b. One low durometer rubber snow pad fell off the right track. Further investigation revealed that four out of 11 snow pads checked on the left track were below the prescribed torque of 160 foot-pounds, and 16 out of 26 checked on the right track were also below the prescribed torque. Incident occurred after 2,173.9 miles of operation (paragraph 1.3, appendix II). (Deficiency)

With the exception of the failure to retain torque reported in paragraph 2.6.1, the pad remained durable and functional for the duration of the test. Complete measurements of a representative sample of test pads appear in table 1, appendix I. The pads showed negligible degradation in width, length, and thickness. The secondary roads in the area of operation were not completely covered with snow at all times during the test season, and occasionally the vehicle was operated over a surface of snow and gravel. Contact with the gravel caused some chunking of the pad, particularly at the leading edge. However, this was limited in extent, and did not impair the performance of the snow pad, in either traction or self-cleaning properties.

The only failure of the low durometer pads was the loss of 10 pads, eight from the right track and two from the left. The most likely cause of these failures was the lack of torque retention which is a characteristic of the retaining nuts on the low durometer pad in its present design.

2.6.2.4 Analysis. The low durometer test snow pad is durable for at least 2,000 miles under arctic winter conditions.

Using the binomial model of statistical evaluation, the 90 percent confidence interval estimate of the expected life of 90 percent of the test pads was made. Support in this evaluation was supplied by statisticians at the U. S. Army Test and Evaluation Command, Aberdeen Proving Ground.

Considering the loss of ten test pads as ten independent failures within a complete set of 151 track pads, it can be assumed with 90 percent confidence that at least 89.98 percent of the test pads will remain durable over 2,173.9 miles.

The requirement for this type of statisitical evaluation was based on the assumption that the test pads would fail for a variety of reasons at irregular intervals throughout the length of the durability exercise. This did not happen. All 10 failures are attributed to a single cause, for which corrective action has been outlined in paragraph 2.6.1.4. If the corrective action suggested is applied in all further uses of the test pads, the likelihood of a repetition of the same kind of failure is greatly reduced. This would eliminate the validity of the statistical method used above for determining the expected life of the test pads.

The accurate evaluation of the durability of the low durometer rubber snow pads must be based on the performance of the 141 pads which remained on the vehicle throughout the test. Ten pads fell off. This failure was not a durability failure, but one of reliability, or retention. All 141 pads which remained on the vehicle throughout the durability exercise remained functional. As a result of the discovery of the missing pads, the torque of the retaining nuts was checked and found below 160 foot-pounds. Increasing the torque above 160 foot-pounds would result in a loss of the resilient character of the pads. Further loss of pads was avoided by periodic retorquing.

The constant need to retorque indicated clearly to test personnel that the retaining nut on the low durometer rubber snow pads is not reliable under arctic winter conditions. This deficiency must be corrected by a completely self-locking nut, or other design modifications. If this is not done, instructions to check torque of the retaining nut at least every 500 miles must be sent to users before the low durometer rubber snow pad is considered fully suitable for use under arctic winter conditions.

2.6.3 Tools and Equipment

2.6.3.1 Objective. Determine if the standard issue OEM tools are adequate to maintain the test track pads.

2.6.3.2 Method. All maintenance was performed using standard issue tools (OEM) in accordance with prescribed maintenance procedures.

2.6.3.3 Results. During the installation of all three types of test snow pads, two tools were necessary; an impact wrench and a torque wrench. The impact wrench is supplied with the vehicle, and has a torque setting. However, the wrench will not set torque precisely enough for use with the test snow pads, in particular with the spring loaded pads, which are torqued to only 20 foot-pounds. When torquing the low durometer and steel grouser pads to 160 foot-pounds, the impact wrench was off up to 30 foot-pounds. The torques had to be adjusted manually.

Only one 15/16-inch socket is supplied with the vehicle OEM. If the impact wrench and a torque wrench are used together, an additional 15/16-inch socket is required.

For the removal of the snow pads, two tools are necessary; an impact wrench and a breaker bar. Both tools are supplied with the vehicle OEM. Again, a second 15/16-inch socket is needed.

The crew reported greater difficulty in handling the vehicle impact wrench than in handling the smaller electric impact wrench. The electric wrench fit in between road wheels, enabling the crew to loosen more pad bolts at a time during removal of the pads. The only place the crew was able to apply the vehicle impact wrench was between the first road wheel and the drive sprocket. This increased time to remove the set. The crew reported a preference for the electrical wrench during installation.

2.6.3.4 Analysis. The standard issue OEM tools supplied with the vehicle are not adequate to maintain the test snow pads.

A manual torque wrench, capable of measuring up to 200 foot-pounds, and an additional 15/16-inch, 1/2-inch drive socket are needed for complete installation, removal, and maintenance capability at the operator/crew level.

SECTION 3. APPENDICES

APPENDIX I TEST DATA

TABLE 1.--Measurements of Low Durometer Rubber Snow Pads

	Pad Number	Length (Inches)	Width (Inches)	Thickness (Inches)
Initial Measurements	1	9.45	4.70	1.20
	2	9.45	4.70	1.20
	3	9.47	4.70	1.20
	4	9.45	4.67	1.25
	5	9.47	4.67	1.22
	6	9.45	4.67	1.20
Average Measurements		9.47	4.68	1.21
Measurements after 2,173.9 Test Miles	1	9.36	4.65	1.20
	2	9.40	4.65	1.25
	3	9.42	4.65	1.19
	4	9.40	4.65	1.20
	5	9.40	4.76	1.17
	6 (missing)			
Average Measurements		9.39	4.67	1.20

TABLE 2.--Measurements of Steel Grouser Snow Pads

	Pad Number	Length (Inches)	Width (Inches)	Thickness to Top of Grouser (Inches)	Grouser Length (Inches)	Grouser Width (Inches)
Initial Measurements	1	9.37	4.82	1.70	5.10	.67
	2	9.42	4.82	1.70	5.15	.67
	3	9.42	4.82	1.72	5.15	.70
	4	9.45	4.82	1.72	5.10	.67
	5	9.42	4.80	1.70	5.10	.65
	6	9.40	4.80	1.75	5.12	.67
Average Measurement		9.41	4.81	1.71	5.12	.67
Measurements after 536.4 Test Miles	1	9.44	4.81	1.72	5.12	.70
	2	9.45	4.80	1.57	5.15	.70
	3	9.45	4.78	1.57	5.12	.69
	4	9.40	4.77	1.51	5.12	.70
	5 (missing)					
	6 (missing)					
Average Measurement		9.43	4.79	1.59	5.13	.69

TABLE 3.--37 Percent Slope Test
Steel Grouser Snow Pads

Slope (Percent)	Attempts	Remarks
8 to 12	1	Vehicle was unable to negotiate this slope while towing another M578 vehicle. Complete slippage encountered at base of slope. Snow conditions: 12 to 14 inches of loose virgin snow.
15 to 25	1	Vehicle, without towed load, negotiated slope without slip. Snow conditions: 12 to 18 inches of loose virgin snow.
25 to 35	1	Vehicle, without towed load, negotiated slope with some slip at crest of hill. Snow conditions: 12 to 16 inches of loose virgin snow.
37	3	Vehicle, without towed load, from a standing start could not negotiate slope. Full slip was incountered halfway up the slope. Second attempt was from a running start, however, vehicle unable to negotiate with full slip at 3/4 of the way up the slope. Third attempt from a running start, vehicle made slope with excessive slip. Snow conditions: 4 inches of loose virgin snow with a base of 2 inches of frozen ice and snow.

NOTE: Ambient Temperature: -12°F.

TABLE 3.--37 Percent Slope Test (Cont'd)
Low Durometer Rubber Snow Pads

Slope (Percent)	Attempts	Remarks
8 to 12	1	Vehicle was unable to negotiate this slope while towing another M578 vehicle. Full slip encountered at base of hill. Snow conditions: 12 to 14 inches of loose virgin snow.
15 to 25	1	Vehicle negotiated slope with no slip, without towed load. Snow conditions: 12 to 18 inches of loose virgin snow.
25 to 35	1	Vehicle, without towed load, made slope with some slip 1/4 of the way up the slope. Snow conditions: 12 to 16 inches of loose virgin snow.
37	1	Vehicle without towed load slope with a running start with very little slip. Snow conditions: 4 inches of loose churned snow over 2 inches of frozen ice and snow.

NOTE: Ambient Temperature: -12°F.

TABLE 4.--Torque Check of Low Durometer Rubber Snow Pads
Test Mile 1,812.2

Pad Number	Torque (foot-pounds)
Right Track	
1	150
2	150
3	10
4	10
5	125
6	125
7	125
8	75
9	125
10	10
11	50
12	25
13	25
14	160
15	150
16	25
17	25
18	150
19	50
20	50
21	100
22	75
23	50
24	25
25	25
26	75
27	100
28	100
29	50
30	150
31	75
32	80
33	80
34	80

TABLE 4.--Torque Check of Low Durometer Rubber Snow Pads
Test Mile 1,812.2 (Cont'd)

Pad Number	Torque (foot-pounds)
35	10
36	75
37	25
38	75
39	35
40	50
41	75
42	100
43	75
44	50
45	100
46	125
47	100
48	0
49	0
50	10
51	10
52	30
53	40
54	50
55	60
56	100
57	100
58	100
59	80
60	80
61	80
62	100
63	75
64	75
65	85
66	60
67	10
68	10
69	0

TABLE 4.--Torque Check of Low Durometer Rubber Snow Pads
Test Mile 1,812.2 (Cont'd)

Pad Number	Torque (foot-pounds)
70	0
71	100
72	10
73	10
74	100
75	10
Left Track	
1	125
2	15
3	100
4	150
5	125
6	50
7	160
8	160
9	100
10	75
11	150
12	150
13	150
14	25
15	100
16	100
17	25
18	25
19	25
20	100
21	100
22	150
23	150
24	100
25	150

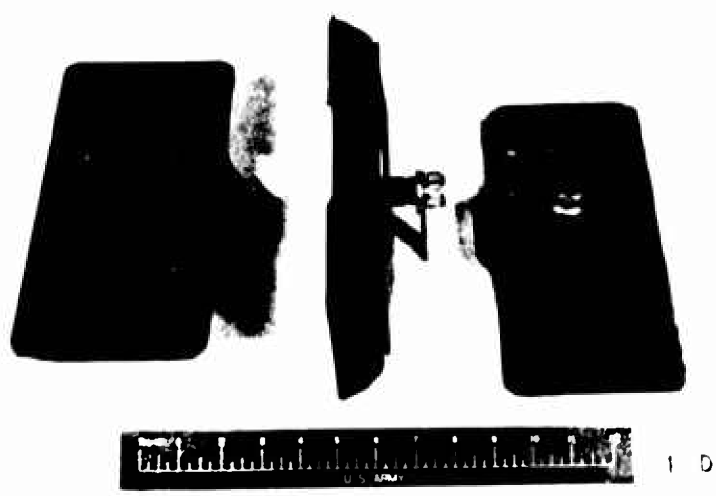
TABLE 4.--Torque Check of Low Durometer Rubber Snow Pads Test Mile 1,812.2 (Cont'd)

Pad Number	Torque (foot-pounds)
26	50
27	50
28	100
29	50
30	150
31	150
32	125
33	120
34	60
35	60
36	65
37	75
38	10
39	50
40	50
41	80
42	75
43	50
44	50
45	75
46	50
47	25
48	75
49	35
50	40
51	30
52	60
53	100
54	140
55	100
56	100
57	30
58	0
59	0
60	25

TABLE 4.--Torque Check of Low Durometer Rubber Snow Pads Test Mile 1,812.2 (Cont'd)

Pad Number	Torque (foot-pounds)
61	100
62	0
63	100
64	100
65	75
66	80
67	80
68	100
69	0
70	100
71	110
72	125
73	100
74	150
75	10

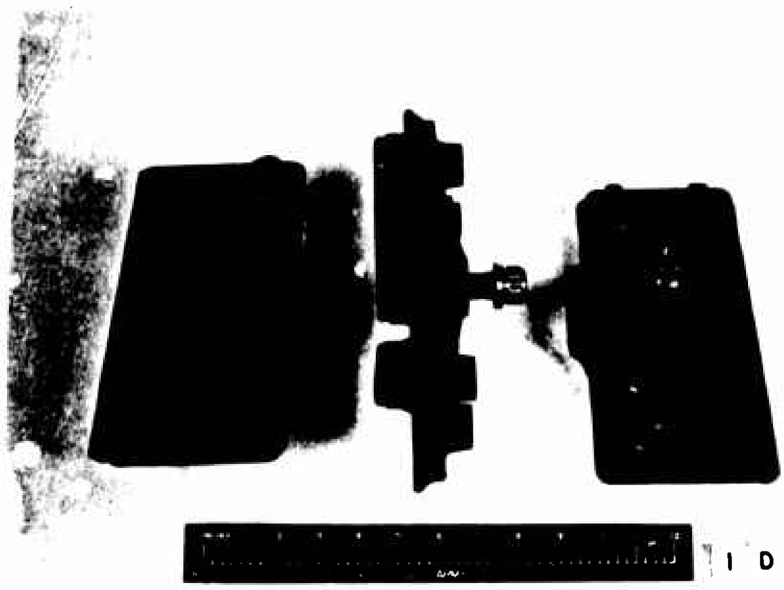
Torque data on pad No. 151 not available.



6 MARCH 1968 USAATC NEGATIVE NO. 359 1-4

FIGURE 1

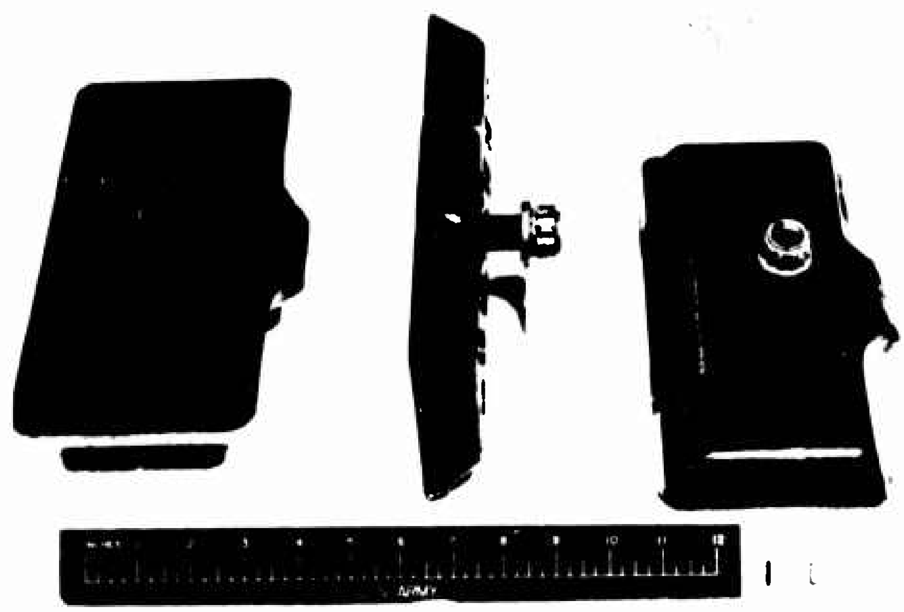
THREE VIEW IDENTIFICATION PHOTOGRAPH
OF SPRING LOADED RUBBER TRACK PAD
FOR M578.



6 MARCH 1968 USAATC NEGATIVE NO. 359 2-4

FIGURE 2

THREE VIEW I.ENTIFICATION PHOTOGRAPH
OF GROUSER TRACK PAD FOR M578.



25 NOVEMBER 1968 USAATC NEGATIVE NO. 168 1-1

FIGURE 3

THREE VIEW IDENTIFICATION PHOTOGRAPH
LOW DUROMETER RUBBER TRACK PAD FOR
M578.

FIGURE 4

DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
17 JANUARY 1969

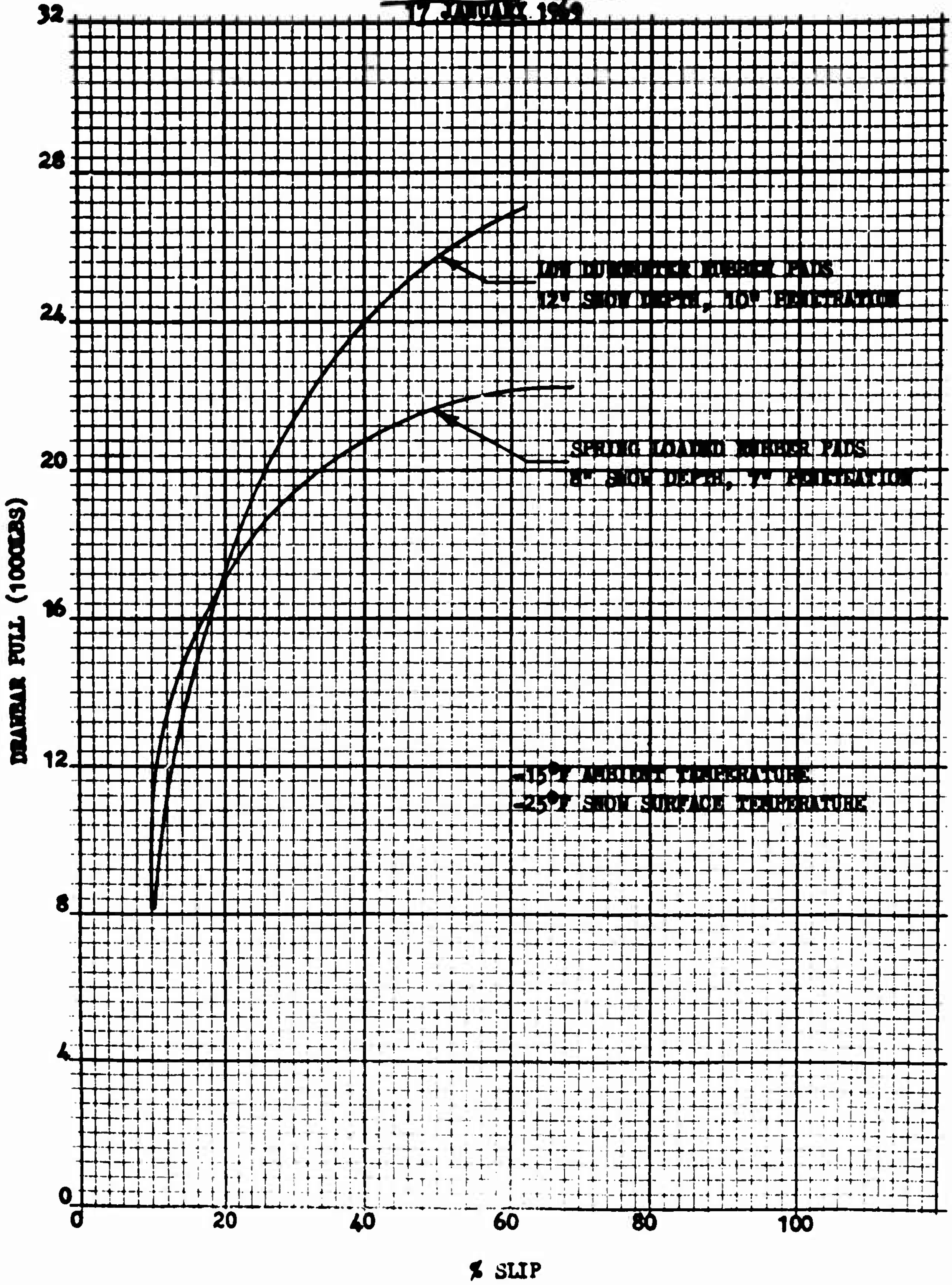


FIGURE 5

DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
17 JANUARY 1969

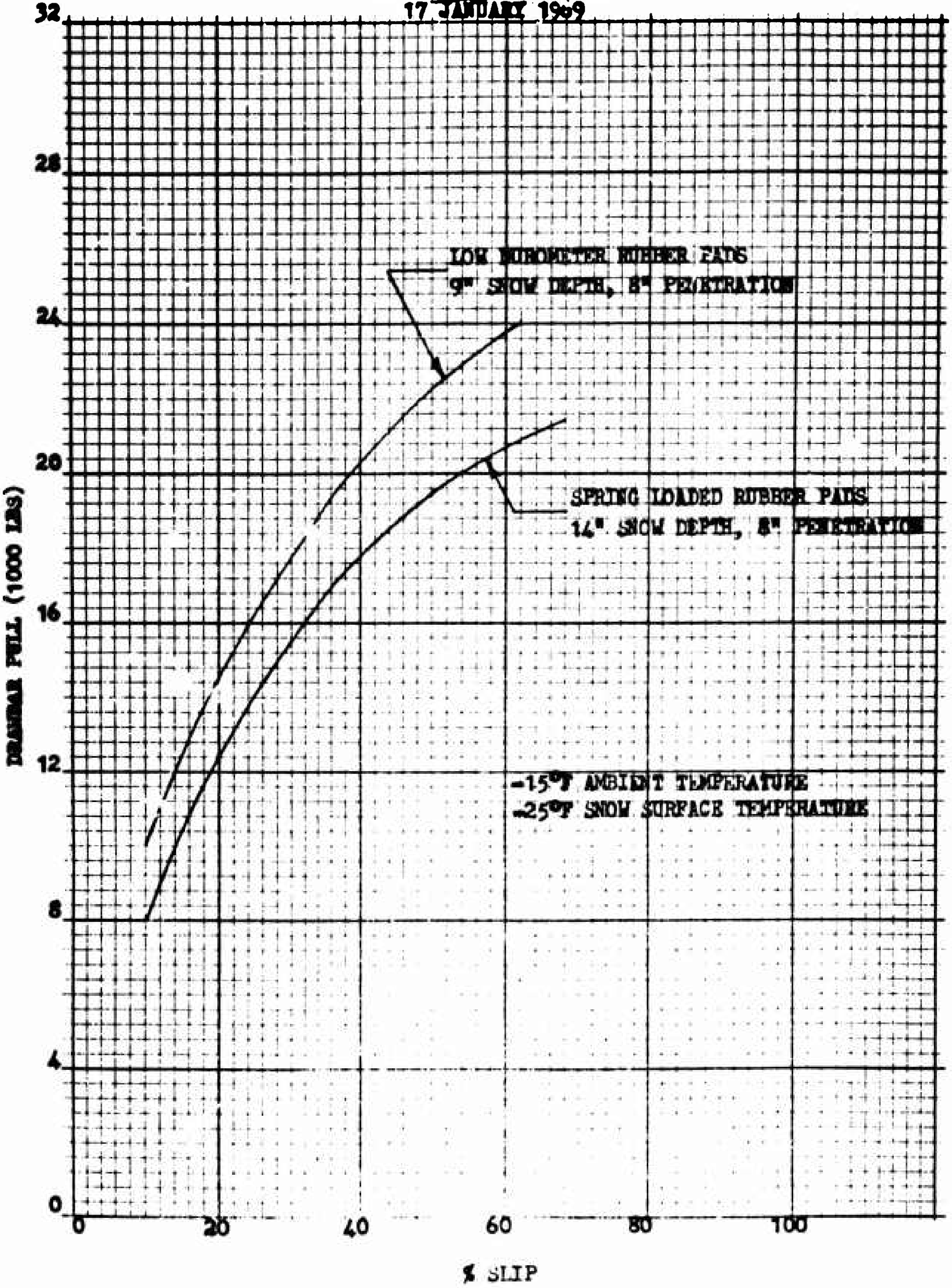


FIGURE 6

DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
17 JANUARY 1969

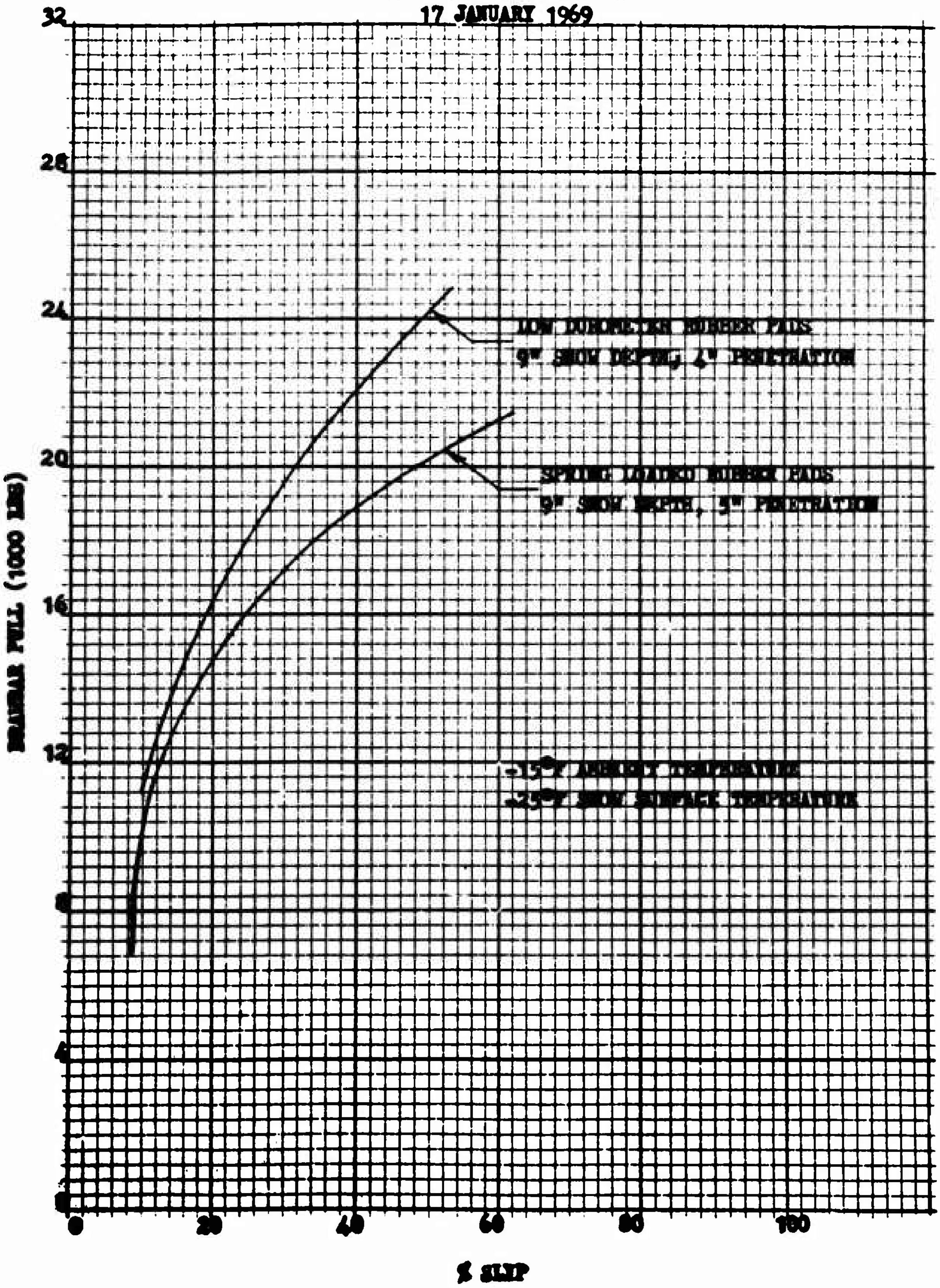


FIGURE 7
DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
13 JANUARY 1969

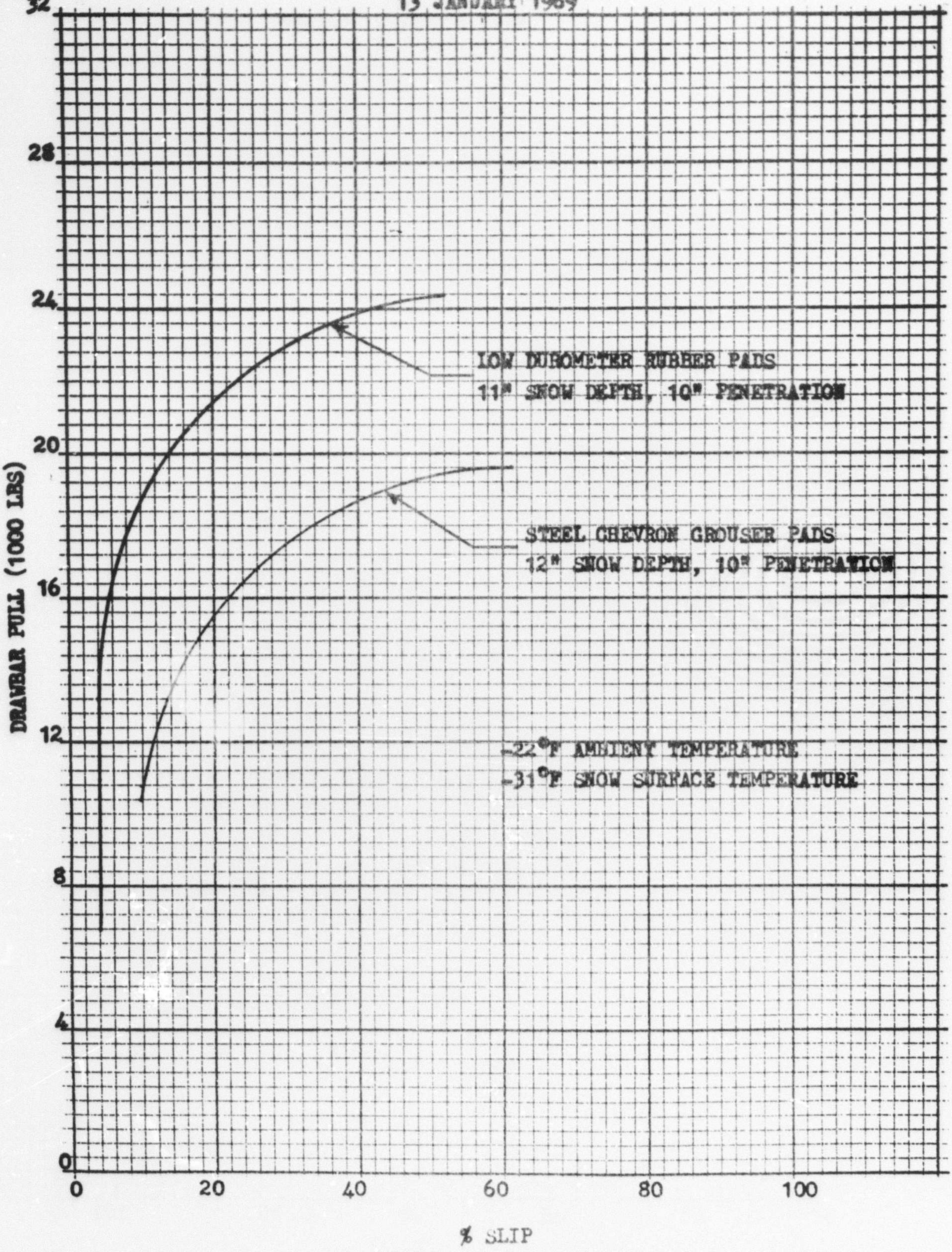


FIGURE 8

DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
13 JANUARY 1969

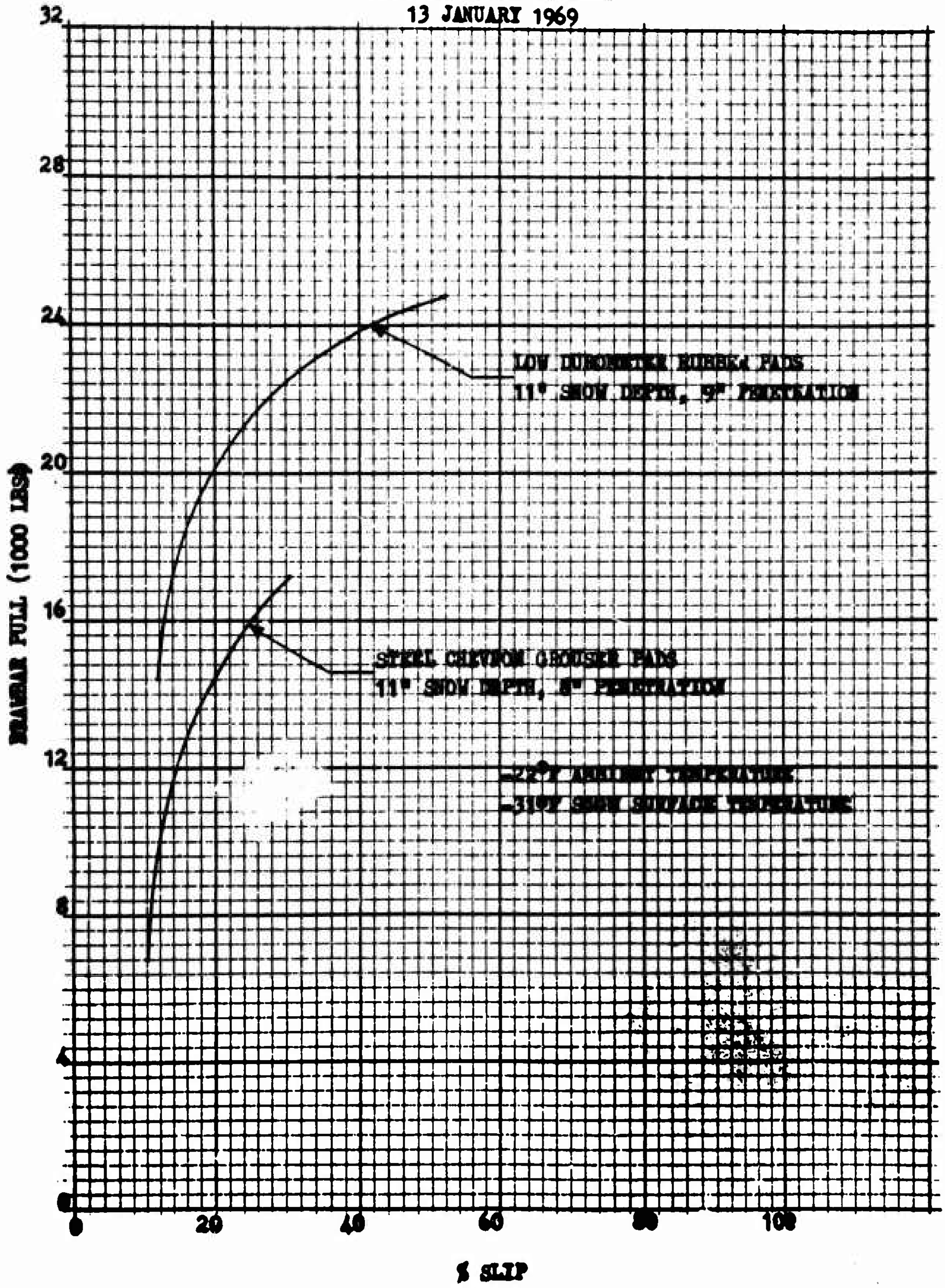


FIGURE 9
DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
20 MARCH 1969

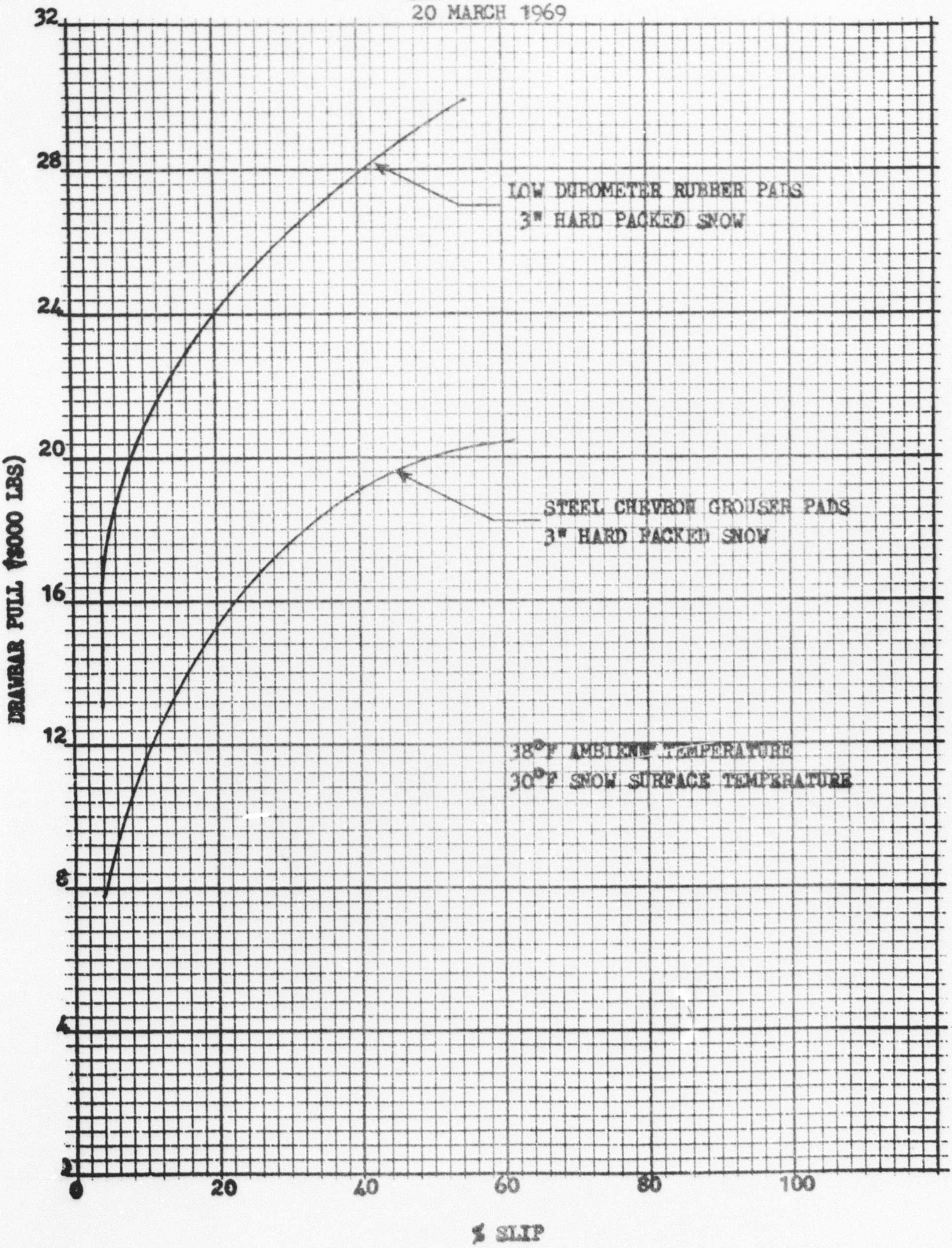


FIGURE 10

DRAWBAR PULL VS SLIP

FOR

M578 RECOVERY VEHICLE

20 MARCH 1969

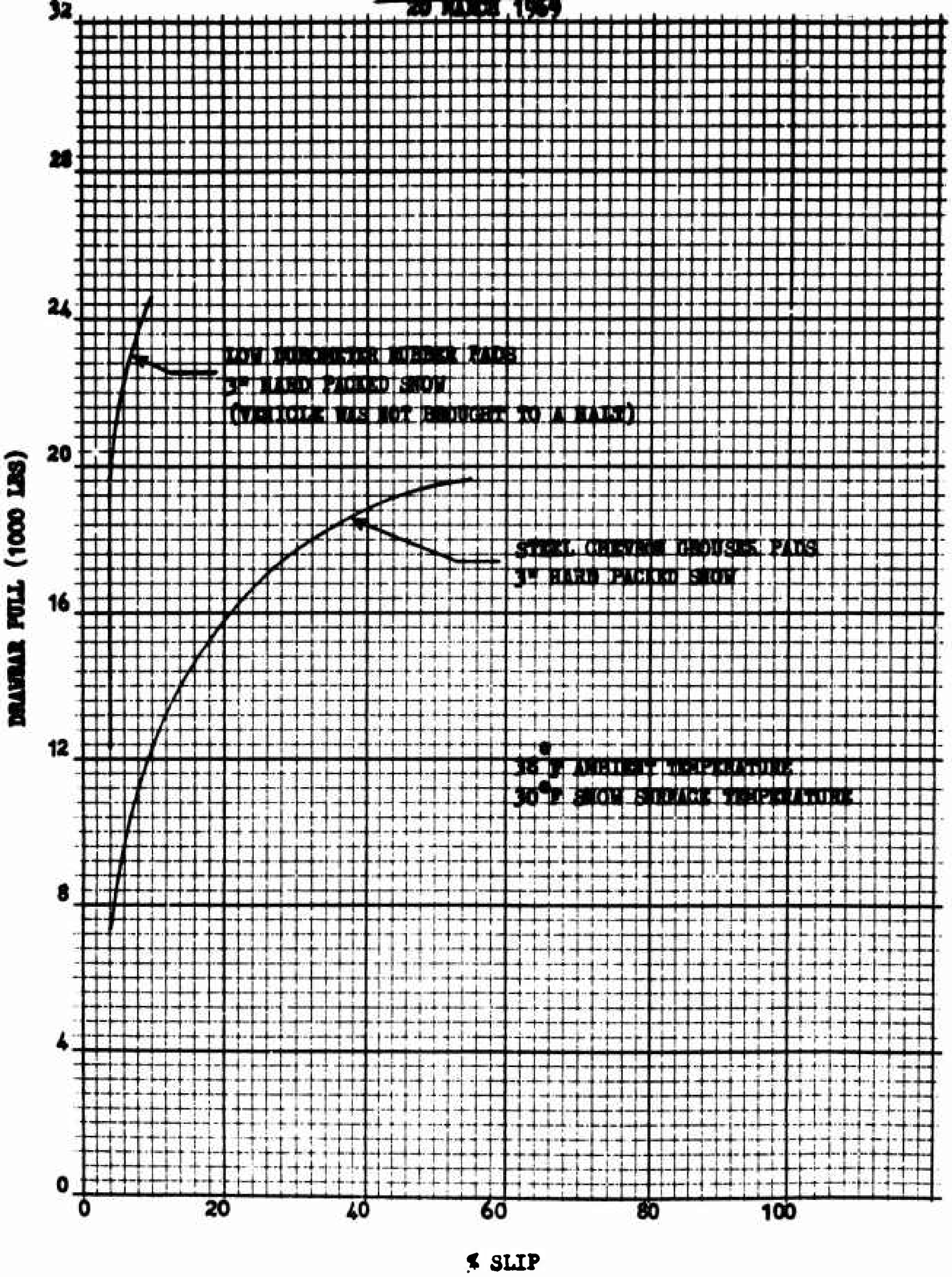


FIGURE 11
DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
19 FEBRUARY 1969

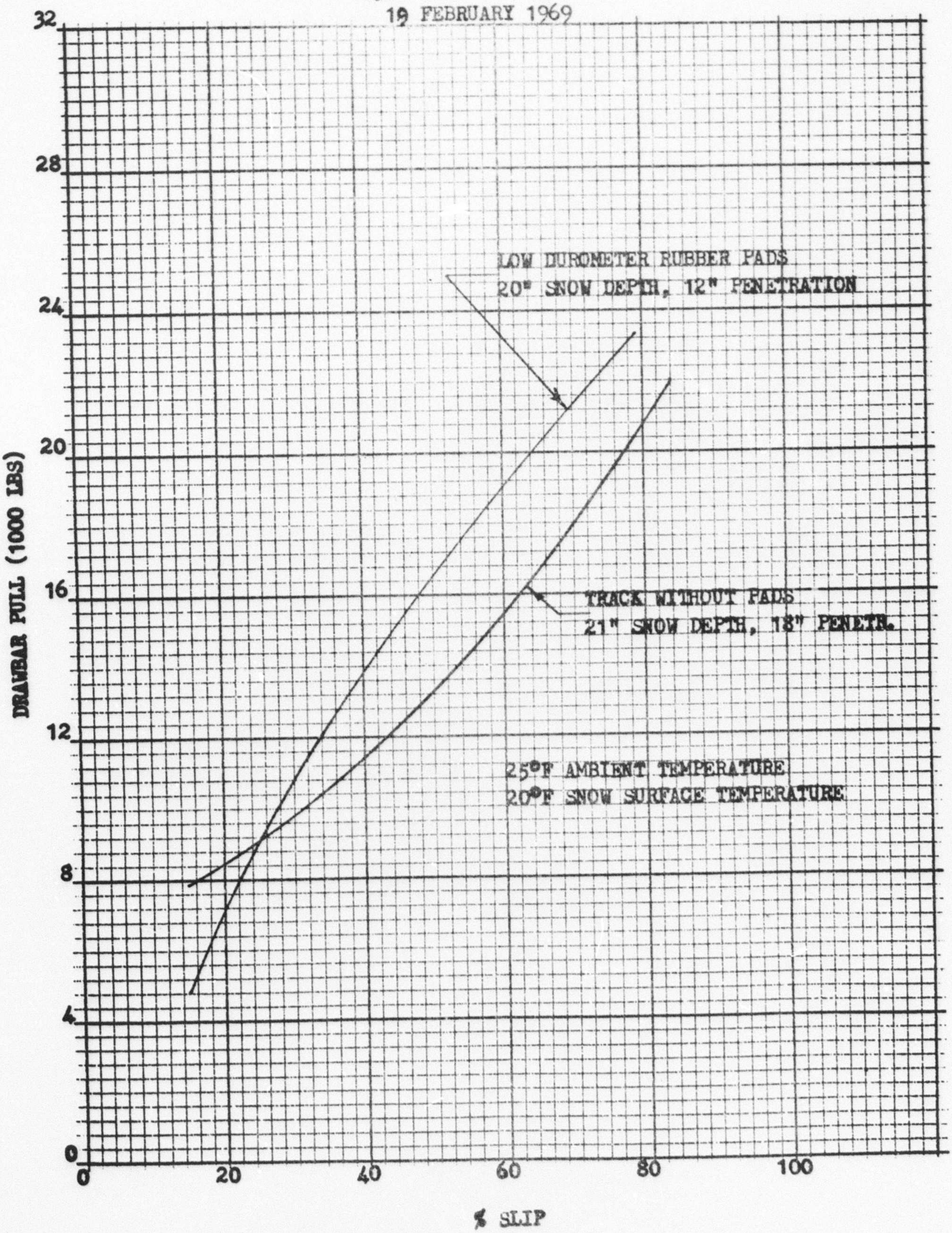


FIGURE 12

DRAWBAR PULL VS SLIP

FOR

M578 RECOVERY VEHICLE

19 FEBRUARY 1969

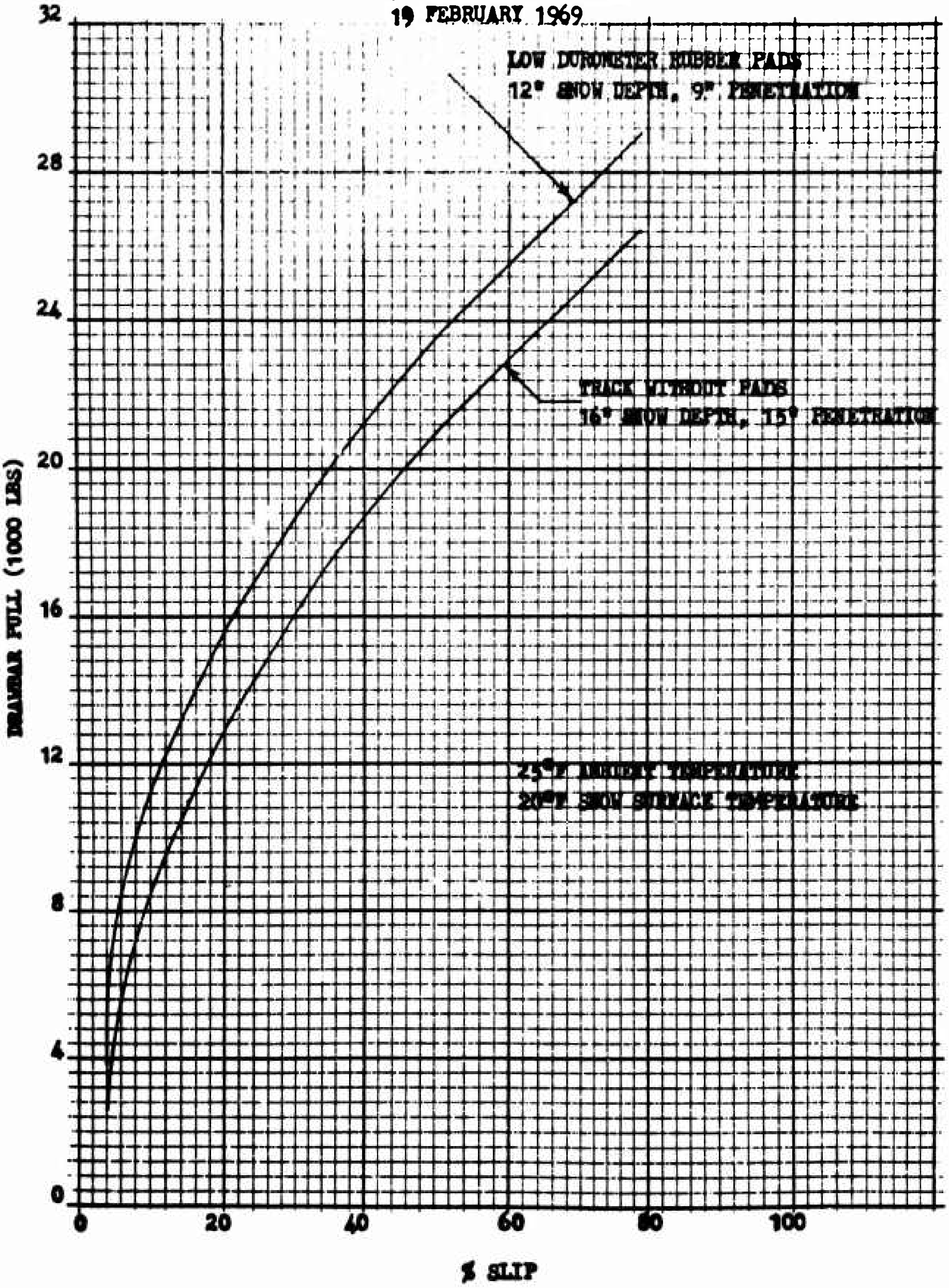


FIGURE 13
DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
19 FEBRUARY 1969

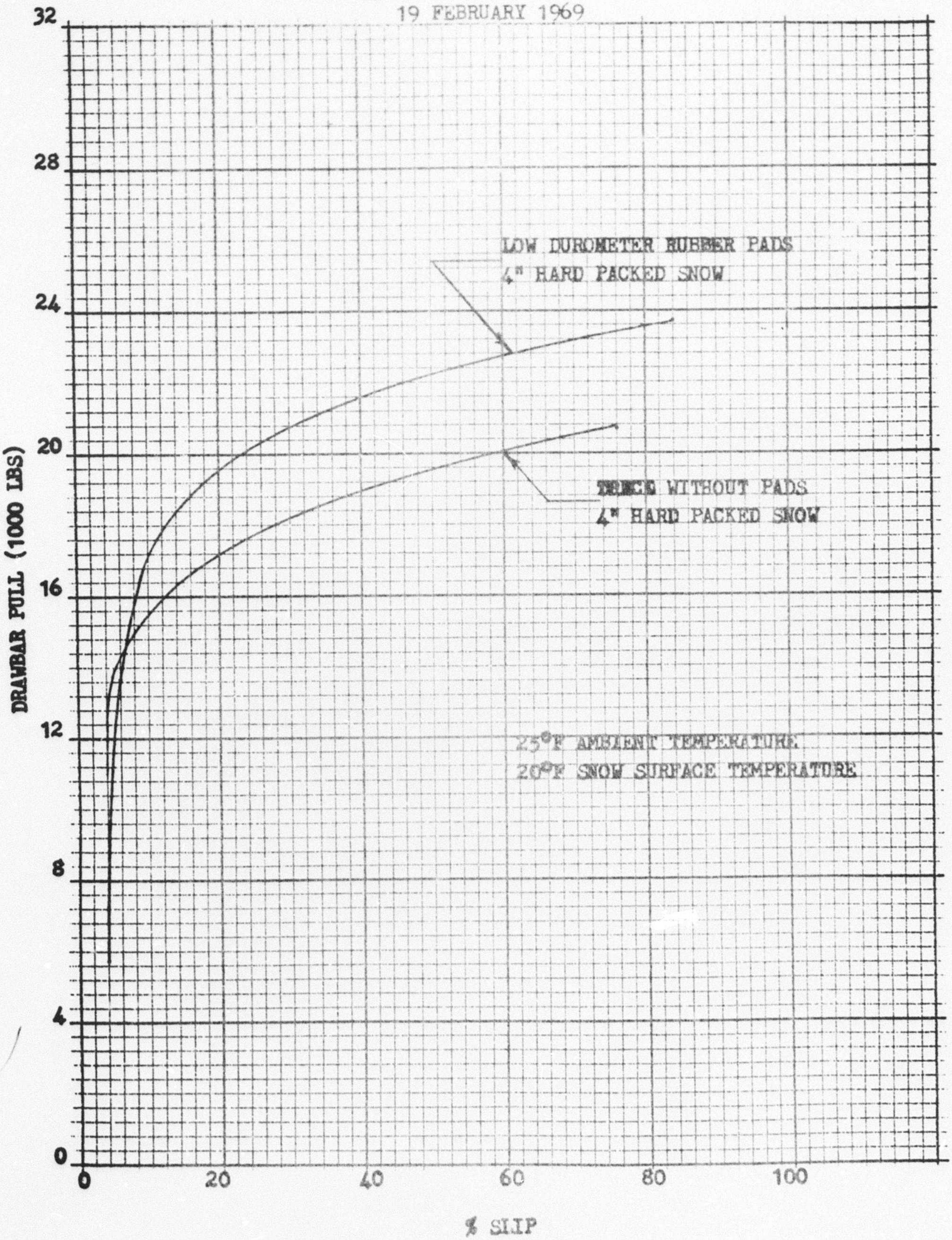


FIGURE 14

DRAWBAR PULL VS SLIP
FOR
M578 RECOVERY VEHICLE
19 FEBRUARY 1969

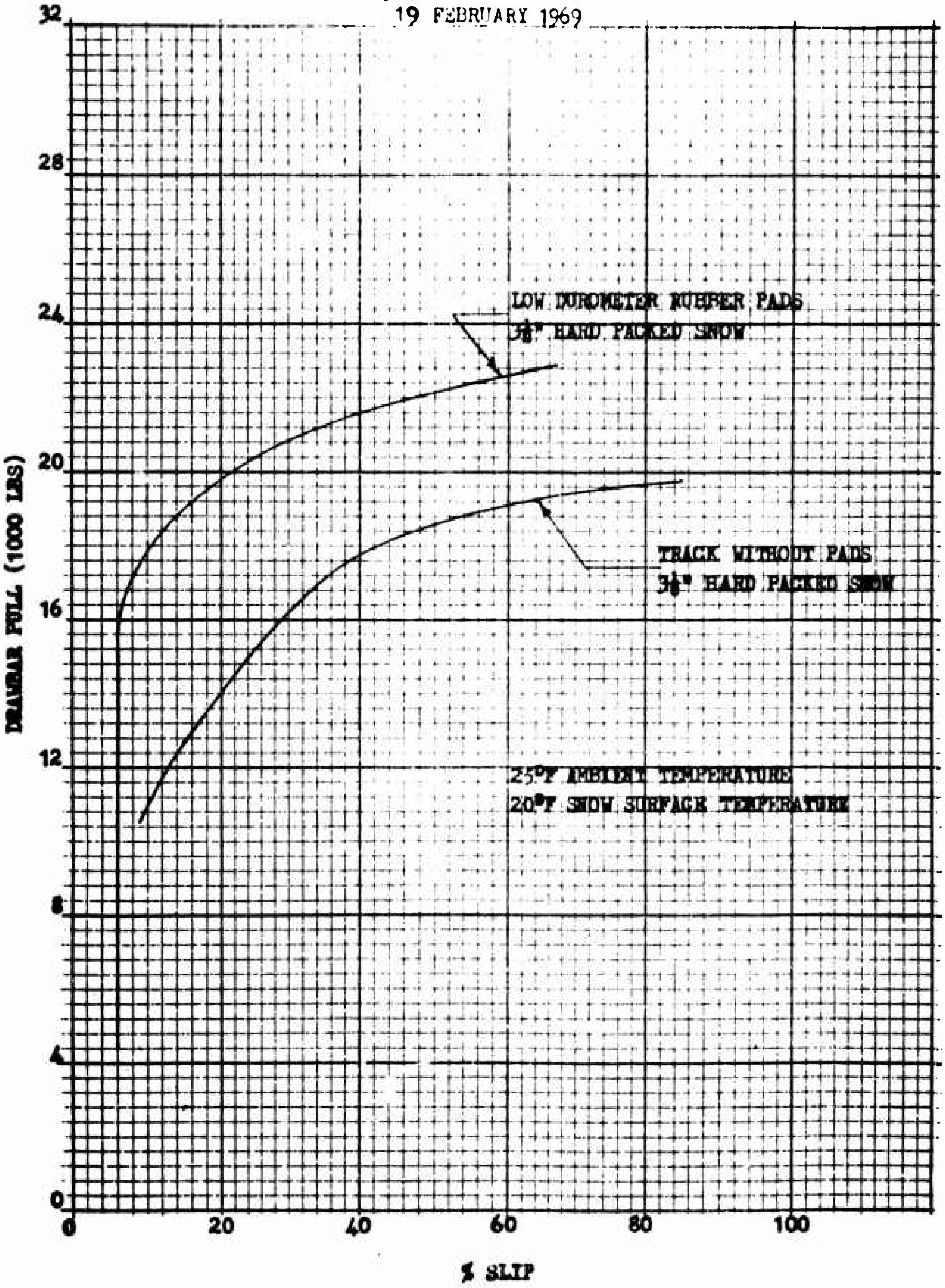
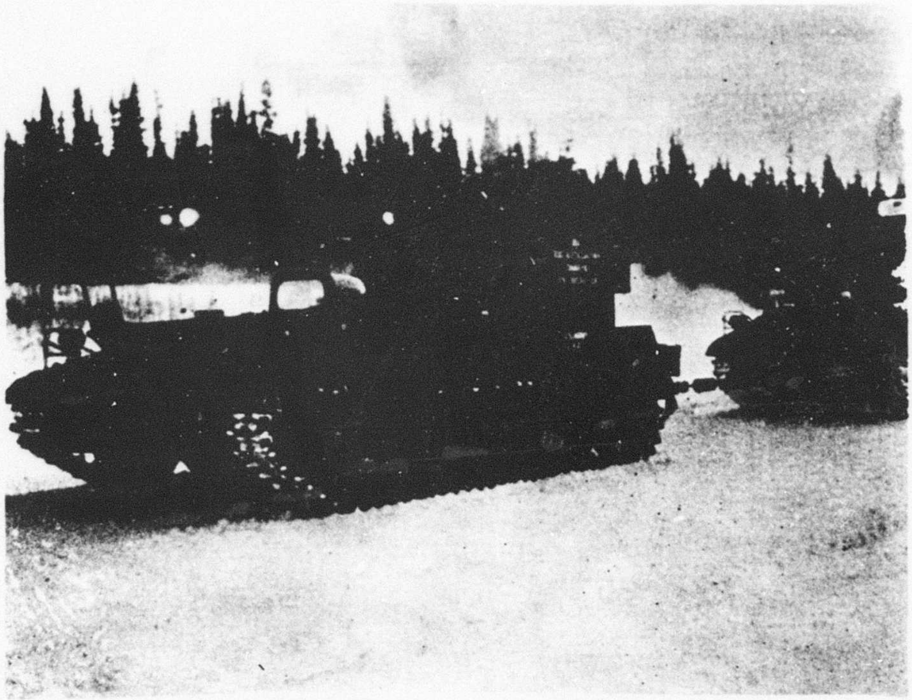


FIGURE 15

M578 TRACK TEST



USAATC NEGATIVE NO. ________

PHOTOGRAPH SHOWS TESTING AREA FOR HARD-PACKED SNOW TRIALS. SPROCKET COUNTER CAN BE SEEN ON THE LEAD VEHICLE; LOAD CELL IS VISIBLE BETWEEN THE VEHICLES, AND THE FIFTH WHEEL IS MOUNTED AT THE REAR OF THE LOAD VEHICLE.

FIGURE 16

M578 TRACK TEST

STEEL CHEVRON GROUSER ON UNDISTURBED SNOW

13 JANUARY 1969

USAATC NEGATIVE NO. ________

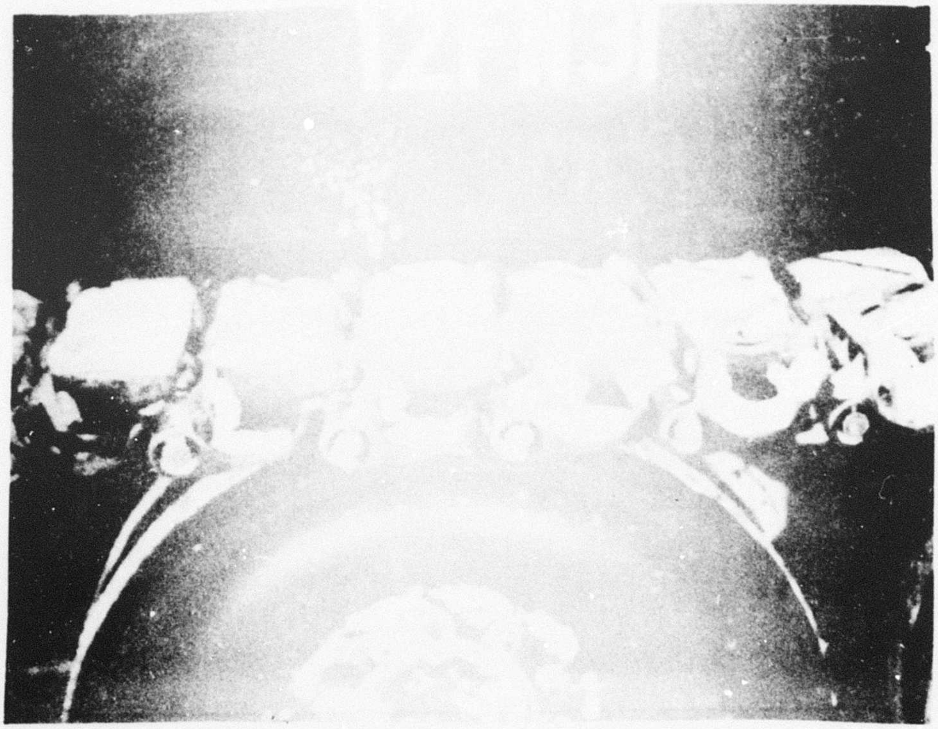
PHOTOGRAPH SHOWS STEEL CHEVRON GROUSERS FOLLOWING A SLIP-PULL TEST IN 12 INCHES OF UNDISTURBED SNOW. THE AMBIENT TEMPERATURE WAS -22°F; SNOW SURFACE TEMPERATURE WAS -31°F.

FIGURE 17

M578 TRACK TEST

STEEL CHEVRON GROUSER ON HARD VEHICLE-PACKED SNOW

13 JANUARY 1969



USAATC NEGATIVE NO. ________

PHOTOGRAPH SHOWS STEEL CHEVRON GROUSERS FOLLOWING A SLIP-PULL TEST ON 3 TO 4 INCHES OF HARD VEHICLE-PACKED SNOW. THE AMBIENT TEMPERATURE WAS -22°F; SNOW SURFACE TEMPERATURE WAS -31°F.

FIGURE 18

M578 TRACK TEST

LOW DUROMETER RUBBER PADS ON UNDISTURBED SNOW

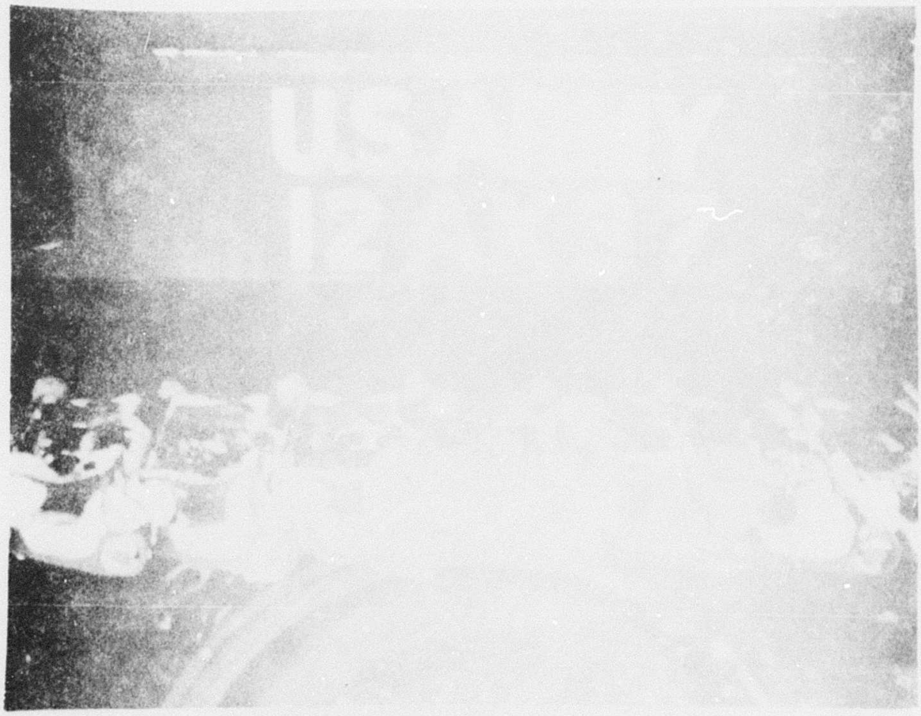
USAATC NEGATIVE NO. ________

PHOTOGRAPH SHOWS LOW DUROMETER RUBBER PADS FOLLOWING A SLIP-PULL TEST ON 11 INCHES OF UNDISTURBED SNOW. THE AMBIENT TEMPERATURE WAS -22°F; SNOW SURFACE TEMPERATURE WAS -31°F.

FIGURE 19

M578 TRACK TEST

LOW DUROMETER RUBBER PADS ON HARD VEHICLE-PACKED SNOW



USAATC NEGATIVE NO. ________

PHOTOGRAPH SHOWS LOW DUROMETER RUBBER PADS FOLLOWING A SLIP-PULL TEST ON HARD VEHICLE-PACKED SNOW. THE AMBIENT TEMPERATURE WAS -22°F; SNOW SURFACE TEMPERATURE WAS -31°F.

APPENDIX II DEFICIENCIES AND SHORTCOMINGS

1. DEFICIENCIES

Deficiency	Suggested Corrective Action	Remarks
1.1 During a Tractive Effort test on 2 inches of hard-packed snow, the leading edge of 15 spring loaded rubber snow pads was pulled out of the pad cavity and bent upwards allowing snow to pack in between the leading edge of the snow pad and the bottom of the track cavity. Two spring loaded pads were also found missing from the track (paragraph 2.6.2.3 and EPR KC-2).	Unknown	Incident occurred after 6.3 test miles. Temperature: -15°F. At the time of incident, the M578 equipped with the spring loaded pads was being towed by another M578.
1.2 Seven low durometer snow pads fell off the right track and two pads on the left track. A torque test revealed all pads on both the right and the left track were well below the prescribed torque of 160 foot-pounds (paragraph 2.6.2.3 and EPR KC-3).	A completely self-locking nut is required. In the absence of this, torque must be checked at least every 500 miles.	Incident occurred after 1,812.2 test miles. All pads were retorqued to the prescribed torque.
1.3 One low durometer snow pad fell off the right track. Four out of 11 snow pads checked were below the prescribed torque on the left track and 16 out of 26 checked were below the prescribed torque on the right track (paragraph 2.6.2.3 and EPR KC-4(3-2)).		Incident occurred after 2,173.9 test miles. All pads were removed from the track as all testing was completed.

2. SHORTCOMINGS

Shortcoming	Suggested Corrective Action	Remarks
2.1 One steel grouser snow pad fell off the right track on the comparison vehicle (paragraph 2.6.2.3 and EPR KC-1).	Unknown	Incident occurred during secondary road operation after 303.2 test miles.

APPENDIX III ARCTIC WINTER UNIFORM

The year-round temperature variation peculiar to the arctic prohibits the prescribing of a particular uniform for any season. The clothing which is comfortable at -50°F becomes uncomfortable at -10°F and vice versa. Since this large fluctuation is experienced on an hour-by-hour, day-by-day basis, some degree of flexibility in uniform requirements is necessary.

Since materiel tested under arctic conditions is expected to function under the most adverse conditions, the uniform worn by operating personnel must also be suitable for the most adverse conditions. Accordingly, the "arctic winter uniform" referred to in this report is defined as follows:

a. Shirt, wool, OG 108

b. Trousers, field, OG 107, with liner.

c. Undershirt, winter.

d. Drawers, winter.

e. Socks, wool, cushion sole.

f. Boots, vapor barrier, white.

g. Suspenders.

h. Cap, pile.

i. Parka with liner and hood

j. Mitten set, arctic, with liners.

APPENDIX IV REFERENCES

a. USATECOM Project Transcript Sheet, AMSTE-BB, HQ, USATECOM, 17 August 1967, subject: Test Directive, Product Improvement Test of Snow Pads for M578 Recovery Vehicle.

b. Letter, AMSTA-RBT, HQ, USATAC, 25 July 1967, subject: Test Program: Product Improvement Tests of T132E1 Snow Pads.

c. Letter, AMSTE-BB, HQ, USAATC, 15 August 1968, subject: USATECOM Project No. 1-8-7340-60, Product Improvement Test of T132E1 Track Snow Pads for M578 Recovery Vehicle, DA Project Code NKB.

d. Letter, AMSTA-U, CG, USATACOM, 9 July 1968, subject: Background Information for M578 Recovery Vehicle (T132E1) Track Snow Pad Test Plan.

e. Letter, STEAC-AR, September 1967, subject: Product Improvement Plan of Test of T132E1 Snow Pads for M578 Recovery Vehicle.

f. Approved Plan for Product Improvement Test of T132E1 Snow Pads for M578 Recovery Vehicle, Under Arctic Winter Conditions, RDT&E Project No. Unknown, USATECOM Project No. 1-8-7340-60.

g. Partial Letter Report of Product Improvement Test of T132E1 Snow Pads for M578 Recovery Vehicle, USATECOM Project No. 1-8-7340-60, 20 June 1968.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

U. S. Army Arctic Test Center

2a. REPORT SECURITY CLASSIFICATION

Unclassified

2b. GROUP

3. REPORT TITLE

Product Improvement Test of T132E1 Snow Pads for M578 Recovery Vehicle Under Arctic Winter Conditions.

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Proposed Final 17 September 1968 to 31 March 1969

5. AUTHOR(S) (Last name, first name, initial)

DURSO, JOSEPH P., JR.

WAYNE, ROBERT A.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
April 1969		

8a. CONTRACT OR GRANT NO.

b. PROJECT NO.

RDT&E Project No. Unknown

c.

USATECOM Project No. 1-8-7340-60

d.

9a. ORIGINATOR'S REPORT NUMBER(S)

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. AVAILABILITY/LIMITATION NOTICES

This document may be further distributed by any holder only with specific prior approval of the U. S. Army Materiel Command.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

U. S. Army Test and Evaluation Command

13. ABSTRACT

A Product Improvement Test was conducted on the T132E1 Track Snow Pads for the M578 recovery vehicle by the U. S. Army Arctic Test Center at Fort Greely, Alaska, from 18 November 1968 to 31 March 1969. The test was conducted to determine if the T132E1 track snow pads increased the mobility of the M578 recovery vehicle over arctic terrain.

Three test pad designs were evaluated: low durometer rubber, spring loaded rubber and steel grouser.

The test approach used was to first determine which snow pad design provided the greatest vehicle mobility, and then to test that design for durability under the prevailing environmental conditions. Initial testing of all three types snow pads revealed that the low durometer rubber snow pad provided the best performance in the areas of mobility, slope performance, and tractive effort, over the steel grouser and spring loaded pads. Durability of the low durometer pad was adequate except for frequent loosening of the retaining nut.

It was concluded that the low durometer snow pad increases the mobility of the M578 recovery vehicle more than any other track pad configuration tested under arctic winter conditions. It was recommended that the low durometer rubber snow pads be adopted for U. S. Army use under arctic winter conditions after the retaining nut reliability failure has been resolved. Further testing at this Center was not recommended.

DD FORM 1 JAN 64 1473

UNCLASSIFIED

Security Classification

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
T132E1 Snow Pads						

INSTRUCTIONS

1. **ORIGINATING ACTIVITY:** Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. **REPORT SECURITY CLASSIFICATION:** Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. **GROUP:** Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. **REPORT TITLE:** Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. **DESCRIPTIVE NOTES:** If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. **AUTHOR(S):** Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. **REPORT DATE:** Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. **TOTAL NUMBER OF PAGES:** The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. **NUMBER OF REFERENCES:** Enter the total number of references cited in the report.

8a. **CONTRACT OR GRANT NUMBER:** If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. **PROJECT NUMBER:** Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. **ORIGINATOR'S REPORT NUMBER(S):** Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. **OTHER REPORT NUMBER(S):** If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. **AVAILABILITY/LIMITATION NOTICES:** Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through
________________."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through
________________."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through
________________."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. **SUPPLEMENTARY NOTES:** Use for additional explanatory notes.

12. **SPONSORING MILITARY ACTIVITY:** Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

UNCLASSIFIED
Security Classification